Northern Victoria Long-term Watering Plan

Minor Update

June 2021

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VICTORIA State Government | Environment, Land, Water and Planning

Cover Photo
Campaspe River

Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

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Abbreviations

ARI	Arthur-Rylah Institute for Environmental Research
BE	Bulk entitlement
BWS	Basin-wide environmental watering strategy
CEWH	Commonwealth Environmental Water Holder
CEWO	Commonwealth Environmental Water Office
CMA	Catchment Management Authority
CMS	MDBA Constraints Management Strategy 2013 to 2024
CPUE	Catch per unit effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DELWP	Victorian Department of Environment, Land, Water and Planning
EVC	Ecological Vegetation Class
EWAG	Environmental Watering Advisory Group
EWMP	Environmental Water Management Plan
IPAPF	Invasive Plants and Animals Policy Framework
LTWP	Long-term Watering Plan
MDBA	Murray-Darling Basin Authority
MDBFS	Murray-Darling Basin Fish Survey
MDFRC	Murray-Darling Freshwater Research Centre
MEWG	Basin Plan Monitoring and Evaluation Working Group
PVC	Permissible Consumptive Volume
RCS	Regional Catchment Strategy
RWS	Regional Waterway Strategy
SDL	Sustainable Diversion Limit
SRA	Sustainable Rivers Audit
SWP	Seasonal Watering Plan
SCBEWC	Southern Connected Basin Environmental Watering Committee
TLM	The Living Murray
VEWH	Victorian Environmental Water Holder
VEFMAP	Victorian Environmental Flows Monitoring and Assessment Program
VWQMN	Victorian Water Quality Monitoring Network
WetMAP	Wetland Monitoring and Assessment Program for environmental water
WRPA	Water resource plan area

Glossary

Term	Basin Plan definition (Chapter, Part, Section)	Victorian definition	Example
Asset (see also priority environmental asset)	A water-dependent ecosystem that satisfies at least one of the following criteria: • is formally recognised in international agreements or, with environmental watering, is capable of supporting species listed in those agreements • is natural or near-natural, rare or unique • provides vital habitat • supports Commonwealth, State or Territory listed threatened species or communities • supports, or with environmental watering is capable of supporting, significant biodiversity. For expanded definitions see Schedule 8, also C8, P5, S8.49.	A significant water-dependent ecosystem (place). May be a single wetland, wetland complex, or a river.	Hird Swamp Lake Murphy Piambie WMU Hattah Lakes Kiewa River Broken Creek
Basin Plan	The Basin Plan (MDBA, 2012a) was developed in accordance with the *Water Act 2007* (Cth). It sets out an overarching framework underpinned with specific obligations to enable sustainable use of water resources within the Murray-Darling Basin.		
Basin States	State and Territory jurisdictions within the Murray-Darling Basin (Australian Capital Territory, New South Wales, Queensland, South Australia, Victoria).		
Ecosystem function	A process within or between assets which supports physical or trophic dynamics that benefit the asset and contribute to achieving ecological objectives. Under the Basin Plan an ecosystem function meets at least one of the following criteria: • "supports the creation and maintenance of vital habitats and populations • supports the transportation and dilution of nutrients, organic matter and sediment • provides connections along a watercourse (longitudinal connections) • provides connections across floodplains, adjacent wetlands and billabongs (lateral connections)" (C8, P5, S8.50) (for details see Schedule 9).	A physical process involving the interactions, movement, energy exchange, or condition of biota, soil, water, nutrients, or other physical features, and will support an environmental value.	*Lateral connectivity between floodplains, anabranches and wetlands* *Providing habitat* *Water quality* *Terrestrial litter production (for potential transport to wetlands and rivers)* *Decomposition* *Aquatic primary production.*

Term	Basin Plan definition (Chapter, Part, Section)	Victorian definition	Example
Priority environmental asset or ecosystem function	An ecological asset or ecosystem function (defined above) that can be managed with environmental water (C8, P5, S9.49).	An asset with significant environmental values (as per Schedule 8 of the Basin Plan), that can be managed with some form of environmental water. Important ecosystem functions (as per Schedule 9 of the Basin Plan) that can be managed with some form of environmental water, and are likely to support environmental values at a priority asset.	
Ecological/environmental objective	An objective for the protection, and if necessary, restoration, of a priority environmental asset or priority ecosystem function (C1, P3, S1.07).	The desired condition for specific environmental value(s) that may be managed with environmental water. An objective includes a desired trajectory (e.g. 'maintain' or 'improve') for a desired measurable outcome (e.g. 'extent or 'species richness'). Measured through the more specific ecological target (see below).	*Improve abundance of large-bodied native fish* *Maintain species richness of frog communities.*
Ecological/environmental target	A target that must be met in order to achieve an ecological objective (C1, P3, S1.07).	A measurement of progress towards, or achievement of, the ecological objective. Targets should be specific, measurable, attributable, realistic and timebound. Measured by environmental monitoring at the event-based, intervention, or condition scales. Results of this measurement indicate whether adaptive management is required to accomplish the objective (for example, management of the timing, frequency, duration or volume of environmental water).	*A positive trend in the catch per unit effort (CPUE) of large bodied native fish over the 10-year period to 2025.* *Maintain the number of native frog species recorded in 8 out of 10 years to 2025.*
Environmental watering requirement	The environmental watering requirements of a priority environmental asset or priority ecosystem function, as the case may be, identified using the methods set out in Part 5 of Chapter 8. For details see C8, P5, S8.51.	Hydrological objectives: the flow components (river) or flooding regime (wetland/floodplain) that will support an environmental value reliant on hydrology for all or part of its life cycle. May consist of one or more of cease-to-flows, minimum flows, freshes, bank-full flows, and over-bank flows in a river, or filling volumes and drying in a wetland, plus timing (which seasons during the year), durations (how long does it need to occur for) and recurrence interval (every year or less frequently). May vary for dry, average and wet conditions depending on the hydrological tolerances of the environmental value. Environmental watering requirements / regime: an integration of the hydrological objectives at a specific asset that will support one or more of the ecological objectives, and be the means to achieve the ecological targets. Measured by compliance monitoring for environmental water deliveries.	*Winter fresh of 1,000 – 1,800 ML/day for 1-2 days, once per year in Jul-Aug.* *Maintain baseflows year-round, winter freshes each year, and winter overbank flows 1 in 3 years.*

Term	Basin Plan definition (Chapter, Part, Section)	Victorian definition	Example
Environmental entitlement	see *held environmental water*	An environmental entitlement is a right to water granted to the Victorian Environmental Water Holder for the purpose of maintaining the Environmental Water Reserve or improving environmental values and health of the water ecosystems and other users that depend on environmental condition. Issued by the Minister for Water under the *Water Act 1989* (Vic) and relate to the Commonwealth definition for *held environmental water*	
Environmental value		In this context, an environmental value is a water-dependent species or community present in or supported by an asset or an ecosystem function.	*Murray cod, river red gums, wetland Ecological Vegetation Classes (EVCs), brolga.*
Passing flow		The volume of water that water corporations or licensed diverters are obliged to provide out of storage or past a diversion point before water can be taken for consumptive use.	
Held environmental water	Water available under a water access right; or a water delivery right; or an irrigation right; for the purposes of achieving environmental outcomes (including water that is specified in a water access right to be for environmental use).	Water that is set aside for the environment as an environmental entitlement, as per the *Water Act 1989* (Vic).	
Planned environmental water	As per the *Water Act 2007* (Cth), water that is committed or preserved for achieving environmental outcomes and cannot be taken or used for any other purpose.	May refer to passing flows or above cap water, but only where specifically provided for environmental purposes.	

Summary

This long-term watering plan (LTWP) has been prepared by the Victorian Government in accordance with its obligations under the Murray-Darling Basin Plan ('Basin Plan'). It concerns the Northern Victoria water resource plan area, which extends from the Victorian Alps in the east, to Ballarat to the south and Kerang in the west, and includes the Ovens, Goulburn Broken, Campaspe, and Loddon River systems.

This is a minor update to the 2015 LTWP for Northern Victoria, as required under the Basin Plan (s. 8.22) following the accreditation in 2020 by the Murray-Darling Basin Authority (MDBA) of the Victoria's North and Murray Water Resource Plan (DELWP, 2020) and a minor update to the Basin-wide environmental watering strategy (MDBA, 2019). The most significant changes to this LTWP include:

- Increased information included from asset-based environmental water management plans (EWMPs) (watering requirements and objectives).
- Updated information from Victoria's North and Murray Water Resource Plan[1] (DELWP, 2020), including an updated risks section and definitions of planned environmental water and shared benefit water.
- Better alignment with Basin Plan including cross-reference of objectives with the Basin-wide environmental watering strategy (MDBA, 2019) and Basin Plan environmental watering plan (EWP) including Division 6 principles.
- Information about groundwater dependency of priority environmental assets.
- Inclusion of information on what environmental watering will occur.
- Updated monitoring section.
- Updated list of priority environmental assets and functions.
- Inclusion of revised information from updated EWMPs in northern Victoria.

The next update of this LTWP will occur after the MDBA's update of the Basin-wide environmental watering strategy, planned for 2023.

This LTWP focuses on the use of environmental water to achieve ecological outcomes in the Northern Victoria water resource plan area. It has been developed with regard to the Basin-wide environmental watering strategy (MDBA, 2019) and primarily uses a bottom-up approach, drawing on a considerable body of work undertaken at the regional and asset scale by Catchment Management Authorities (CMAs) in their Regional Catchment Strategies, Regional Waterway Strategies and environmental water management plans (EWMPs). The LTWP describes ecological objectives and targets for water-dependent priority environmental assets (rivers and wetlands) and ecosystem functions in the region, and the corresponding environmental watering requirements for these objectives. However, this LTWP does not provide detailed management guidance for priority environmental assets; this information remains in the asset-scale EWMPs.

The Northern Victoria LTWP fits within Victoria's existing water entitlement and policy framework and has been prepared using best available information at the time of writing. The Northern Victoria LTWP is one of three LTWPs prepared to meet Victoria's planning obligations under Chapter 8 of the Basin Plan. The remaining LTWPs have been prepared for the Victorian Murray and Wimmera-Mallee water resource plan areas.

Key elements of this plan are summarised below.

Priority environmental assets

There are four main river systems and associated wetlands in the Northern Victoria water resource plan area that meet criteria for priority assets, in that they are able to receive environmental water, and meet criteria set out in Schedule 8 of the Basin Plan. The river systems include the Loddon, Campaspe, Goulburn, and Ovens rivers, while wetlands include assets such as the Boort wetland complex, Horseshoe Lagoon and Reedy Swamp.

1. The water resource plans for Northern Victoria and Victorian Murray were both combined in one document.

Priority ecosystem functions

Three main ecosystem functions have been identified for the Northern Victoria water resource plan area: hydrological connectivity, maintenance of water quality and geomorphology. These are considered priority in that they may be managed with environmental water and meet criteria in Schedule 9 of the Basin Plan.

Water-dependent ecological values

The Northern Victoria water resource plan area supports important water-dependent ecological values including native fish (e.g. golden perch, Murray cod and freshwater crayfish); vegetation (e.g. river red gum communities, cane grass and box riparian vegetation); waterbirds (e.g. egrets, marsh sandpipers, and brolgas), as well as frogs, turtles and platypus. Ecosystem functions that support these ecological values include geomorphological condition and hydrological connectivity.

Objectives

The LTWP includes twenty-seven[2] objectives for identified ecological assets and ecosystem functions to support waterway health in the Northern Victoria water resource plan area. These are listed in the table below and were developed from the ecological objectives set in asset-scale EWMPs, which were prepared by CMAs in consultation with local communities.

Objectives were extracted from individual EWMPs and standardised into a consistent suite of language involving trajectory (e.g. improve), aspect (e.g. abundance) and value (e.g. large-bodied native fish). Similar objectives across assets and ecosystem functions were grouped, producing a set of objectives relevant across the water resource plan area.

Theme	No.	Objectives
Connectivity and Functions	NV1	Improve longitudinal connectivity (between river reaches and with the Murray)
	NV2	Maintain water quality within an appropriate range to allow for ecosystem processes
	NV3	Maintain the quality of geomorphic habitat (maintain channel form, clean substrates, prevent stream bed colonisation)
Vegetation	NV4	Maintain the condition of aquatic vegetation in wetlands
	NV5	Maintain the condition of in-channel aquatic vegetation
	NV6	Improve the extent of aquatic vegetation
	NV7	Improve the abundance of aquatic vegetation
	NV8	Improve the species richness of aquatic vegetation in wetlands
	NV9	Improve the species richness of in-channel aquatic vegetation
	NV10	Maintain the extent of river red gum dominated EVCs
	NV11	Maintain the condition of river red gum dominated EVCs
	NV12	Improve species richness of river red gum dominated EVCs
	NV13	Maintain the extent of black box dominated EVCs
	NV14	Reduce the extent of exotic vegetation
Waterbirds	NV15	Improve breeding opportunities for waterbirds
	NV16	Improve habitat for waterbirds
Fish	NV17	Improve abundance of large-bodied native fish
	NV18	Improve abundance of small-bodied native fish in rivers
	NV19	Improve habitat for native fish
	NV20	Improve movement of native fish

2. These objectives are effectively the same as in the original LTWP and are now separated out into different themes to assist alignment with monitoring.

Theme	No.	Objectives
	NV21	Maintain species richness of native fish
Other Fauna	NV22	Improve breeding of platypus and rakali
	NV23	Maintain abundance of platypus and rakali
	NV24	Improve breeding of frog communities
	NV25	Maintain species richness of frog communities
Macroinvertebrates	NV26	Improve abundance of macroinvertebrates
	NV27	Improve number of macroinvertebrate functional groups present

Cooperative arrangements

Victoria has strong cooperative arrangements for the management and delivery of environmental water between holders of held environmental water, waterway managers and owners and managers of environmental assets. The Victorian government has established these arrangements, in consultation with delivery partners and communities. The arrangements are underpinned by a range of policy, regulatory and governance frameworks.

Four types of authorities collaborate to deliver environmental water in Victoria: waterway managers, storage managers (water corporations), environmental water holders and public land managers.

Coordination and cooperation between Victorian environmental watering program partners is critical in ensuring the success of environmental watering activities across the State. As the decision-making body for use of Victoria's held environmental water, the Victorian Environmental Water Holder (VEWH) leads the coordination process.

An annual process takes place that involves CMA planning and consultation with Traditional Owners, communities and stakeholders to prepare Seasonal Watering Proposals; preparation of the Seasonal Watering Plan by the VEWH; consideration and prioritisation of actions in the Seasonal Watering Plan, in consultation with the Commonwealth Environmental Water Holder (CEWH) and the Murray-Darling Basin Authority (MDBA); the release of seasonal watering statements by the VEWH; and delivery coordination and consultation with storage managers. The Southern Connected Basin Environmental Watering Committee (SCBEWC) coordinates the delivery of environmental water across the southern Murray-Darling Basin.

CMAs partner with Traditional Owners and Aboriginal Victorians in the management and planning of waterways and catchments. This includes formally recognised Traditional Owner groups and those that have not yet been formally recognised.

Constraints

Operational and physical constraints limit delivery of water for the environment and the outcomes that can be achieved. These constraints have been examined and prioritised across the Basin, initially through the MDBA's Constraints Management Strategy 2013 to 2024 (MDBA, 2013a) and then through reach-focused projects that are being led by Basin states.

Policy measures to overcome the most notable operational constraints have now been implemented. State-led projects, called 'constraints measures', are exploring the potential impacts of delivering higher flows and how these can be addressed to support system-wide environmental outcomes through the reconnection of rivers to their floodplains. Working closely with affected communities will be critical to success.

Risks

Long-term risks associated with providing for the environmental water requirements under this plan fall into two broad categories:

- Risk of failure to achieve (or demonstrate achievement of) the intended ecological objective.
- Risk of adverse impacts in the provision of environmental water.

The risks associated with a failure to achieve the intended ecological objectives are grouped into four types of risk: failure to provide recommended watering regime, failure to provide complementary works, external factors (e.g. climate change), and failure to demonstrate outcomes.

The risks associated with adverse impacts arising from the provision of environmental water have been assessed by their impact on environmental, social, cultural and economic values and management options identified.

Existing processes are in place for managing these risks at the regional and site-specific scale.

Consultation

Consultation has occurred through a three-part devolved approach. It has aimed to:

- *Involve* local communities, who have worked directly with CMAs to ensure information and concerns were understood and considered.
- *Collaborate* with the VEWH and CMAs, who have provided material and guidance for the LTWP.
- *Consult* with the water corporations, land managers, MDBA, CEWH, upstream and downstream states, and the Murray and Lower Darling Rivers Indigenous Nations (MLDRIN) who provided information where relevant and feedback on the content.

Traditional Owner groups across northern Victoria were consulted on their objectives for water management during preparation of Victoria's North and Murray Water Resource Plan (DELWP, 2020). This included Bangerang, Barapa Barapa, Dhudhuroa, Waywurru, Yaitmathang, Dja Dja Wurrung, First Peoples of Millewa Mallee (Nations of the Nyeri Nyeri, Ngintait and Latji Latji), Tati Tati Wadi Wadi, Taungurung, Wadi Wadi, Wamba Wemba, Weki Weki and Yorta Yorta.

Consultation with relevant Traditional Owner groups on this LTWP was also carried out in 2020, together with consultation on improving the guidance for EWMPs on Traditional Owner partnership. Feedback has informed an update of Victoria's EWMP Guidelines, to be released in June 2021. Due to the heavy reliance of Victoria's LTWPs on EWMPs, this was the key focus for Traditional Owner consultation.

Next Steps

This LTWP is one of several steps towards full implementation of the Basin Plan. Further work will be pursued in the time between this LTWP iteration and the next, due to occur after the next update of the Basin-wide environmental watering strategy in 2023 This work will progress knowledge and application of:

- Landscape scale (top down) approaches that can be integrated with the asset scale (bottom up) approach taken in this LTWP iteration.
- Use of EWMPs to meet LTWP requirements.
- Further asset-based technical work (through EWMPs for new assets, reviews and updates of existing EWMPs where needed, in line with the EWMP Guidelines that were updated concurrent with this LTWP update).

1. Introduction

The Murray-Darling Basin Plan aims to improve water security and establish a sustainable and long-term adaptive management framework for Murray-Darling Basin water resources.

The Basin Plan was released in November 2012 and sets out an overarching framework underpinned with specific obligations, to enable sustainable use of water resources within the Murray-Darling Basin.

The Murray-Darling Basin Authority (MDBA) works with Basin states to implement the Basin Plan. In Victoria, the responsibility for meeting state obligations for the Basin Plan is being met by the Department of Environment, Land, Water and Planning (DELWP), with important contributions from all water resource and asset managers.

All Basin states must develop a series of planning documents under the Basin Plan, including long-term watering plans (LTWPs) for environmental assets and ecosystem functions.

Separate LTWPs have been developed for each of Victoria's water resource plan areas, including the Wimmera-Mallee, Northern Victoria and the Victorian Murray (Figure 1). These areas are based on surface water management boundaries (not catchment boundaries) and include priority rivers and wetlands that may be managed with environmental water.

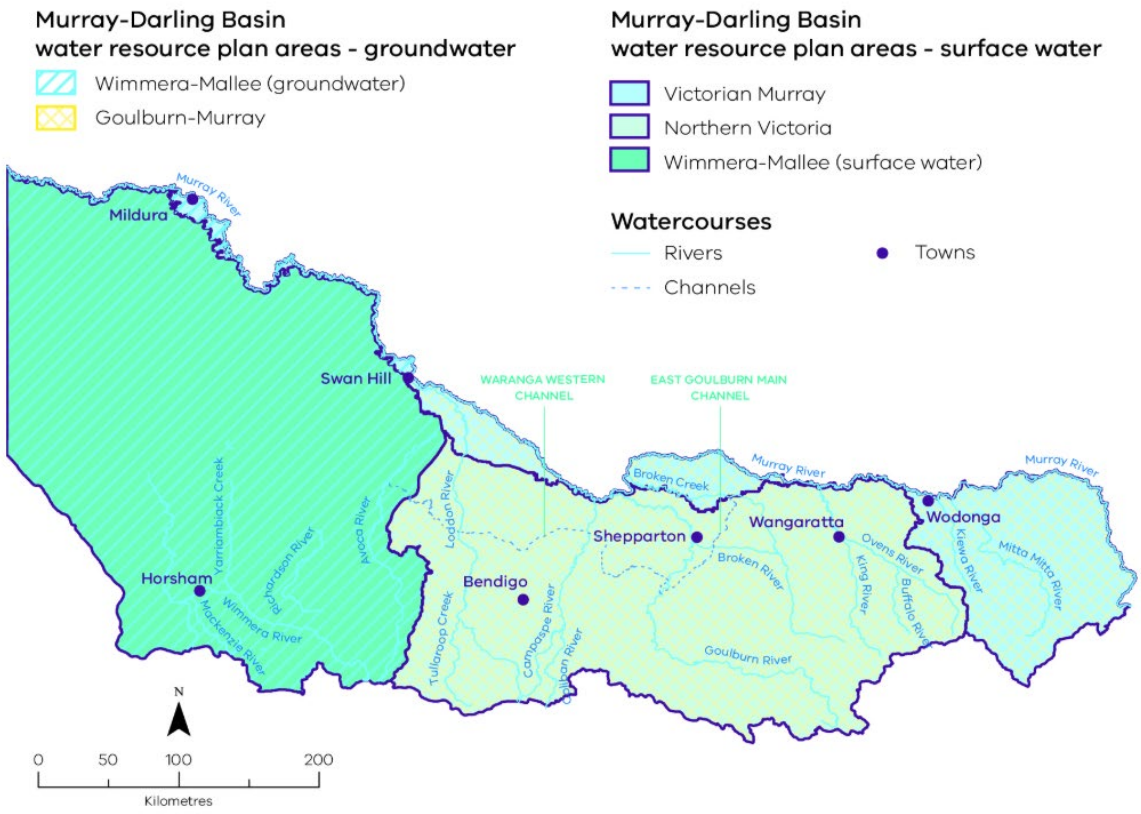


Figure 1: Victoria's three surface water resource plan areas – Victorian Murray, Northern Victoria, and Wimmera-Mallee

This LTWP for the Northern Victoria water resource plan area incorporates information and planning that is both general to Victoria and specific to the water resource plan area. The first version of this LTWP was released in 2015 and this is the first update to it.

1.1 Context

Many Victorian waterways have been highly modified by human use over the past 150 years and the construction and operation of water storages and other water interception activities have altered the natural flow regime of rivers and inundation patterns of wetlands. While complementary catchment management activities are important (see Section 7), environmental water delivery is a critical management tool to improve the health of these areas and support a shared resource that meets economic, cultural and recreational needs.

Provision of a suitable watering regime is essential to achieve the objectives and targets outlined in this plan. This does not require restoration of a completely natural water regime. Specific components may have higher importance for different biota or support vital parts of their lifecycle. Water requirements to meet objectives and targets can be developed so that the volume, timing, duration, frequency and quality of environmental water that is provided is clearly linked to the proposed outcomes from the environmental flows.

Basin Plan

The Basin Plan (MDBA, 2012a) establishes long-term management objectives in relation to:

- Environmental outcomes.
- Water quality and salinity.
- Long-term average sustainable diversion limits.
- Trading in the water market.

For the **environmental outcomes** of the Basin Plan, the MDBA and Basin states (QLD, NSW, VIC, ACT and SA) are working toward attainment of four overarching objectives:

- To protect and restore water-dependent ecosystems of the Murray-Darling Basin.
- To protect and restore the ecosystem functions of water--dependent ecosystems.
- To ensure that water--dependent ecosystems are resilient to climate change and other risks and threats.
- To ensure that environmental watering is co-ordinated between managers of planned environmental water, owners and managers of environmental assets, and holders of held environmental water.

While overall Basin Plan implementation will support these objectives, the most specific actions are set out in Chapter 8 ‘Environmental Watering Plan’, which outlines planning required from the MDBA and Basin states to achieve the objectives. This planning provides for both long-term and annual environmental water objectives, at both the Basin and a more localised scale, as shown in Figure 2.

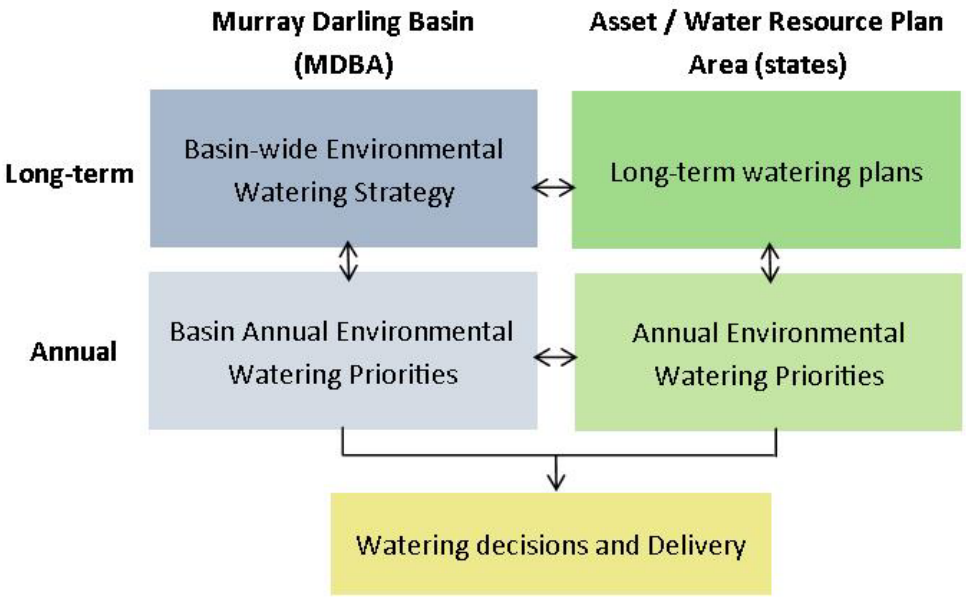


Figure 2: The long-term and annual planning documents required under Basin Plan Chapter 8 'Environmental Watering Plan'

To date, the MDBA and Basin states have completed annual watering priorities for each watering season since 2014-2015. The MDBA also released its first Basin-wide environmental watering strategy in late 2014 (MDBA, 2014a), and updated it in 2019 (MDBA, 2019).

1.2 Scope of the plan

This plan focuses on identifying the environmental watering objectives and requirements of priority river and wetland assets and ecosystem functions to achieve ecological outcomes in the Northern Victoria water resource plan area. It identifies the priority environmental assets and ecosystem functions for the water resource plan area, long-term ecological objectives and targets for these, watering requirements to meet the objectives and targets, cooperative arrangements between delivery partners, high level constraints for the water resource plan area and the long-term risks of providing environmental water. It also describes how the targets in the plan can be monitored and evaluated.

Due to the environmental watering focus, this plan is not intended to provide holistic management for catchments or waterways (this is addressed in the Victorian Waterway Management Strategy (VWMS) (DEPI, 2013b)). However, in recognition of co-dependencies between all waterway management issues, this LTWP also includes a section on complementary actions that must work alongside environmental watering, in order to meet waterway health outcomes.

This plan has been prepared according to the existing Victorian environmental water management framework and processes and using best available information at the time of writing.

The information in this plan has come primarily from asset-based Environmental Water Management Plans (EWMPs) that have been developed by Catchment Management Authorities (CMAs) to guide environmental water use over the long-term. EWMPs have been used as underlying documents to this plan because the content aligns well with Basin Plan requirements for LTWPs. EWMPs must be consulted for full asset-specific information when reading this LTWP and are available at https://www.water.vic.gov.au/waterways-and-catchments/rivers-estuaries-and-waterways/environmental-water/environmental-water-management-plans.

EWMPs are prepared by CMAs in consultation with their local communities. They set out the important ecological values of an asset, the condition of these values, the objectives for environmental watering and the water regime required to meet the objectives. EWMPs also set out constraints to watering at an asset and the risks associated with meeting the watering objectives. The purpose and content of EWMPs are explained in more detail in Appendix B.

A common set of terms has been defined for this LTWP to enable cross referencing between Victoria's three LTWPs and existing state planning documents. The common set of terms enables the application of a consistent language both within this document and across Victoria's three LTWPs (see

Glossary). The definitions and terminology have been based on that adopted and used through Victoria in the development and implementation of EWMPs.

1.3 Purpose of the long-term watering plan

LTWPs assist planning for environmental water outcomes, in order to meet the Basin Plan objectives and targets, and the overall environmental objectives for water-dependent ecosystems outlined in Part 2 of Chapter 8 of Basin Plan.

The requirements for LTWPs are outlined in Chapter 8 of the Basin Plan. A LTWP must have regard to the Basin-wide environmental watering strategy (MDBA, 2019) and be consistent with the principles the Basin Plan sets out for environmental watering (BP Ch 8, Part 6). A table detailing each of the Basin Plan requirements and where they are met in the LTWP is provided in Appendix A. This LTWP also recognises there are Basin-wide obligations to take account of cultural outcomes.

Victoria's LTWPs have collated long-term environmental water planning information for priority rivers, wetlands and ecosystem functions in the Northern Victorian water resource plan area and inform:

- Victoria's Annual Watering Priorities (as per Figure 2).
- The Basin-wide environmental watering strategy and Basin Annual Watering Priorities (as per Figure 2).
- Water resource plans, particularly the environmental watering requirements (see below).
- Long-term outcomes and environmental water demand in the Commonwealth Environmental Water Holder's (CEWH) Portfolio Management Plans.
- Decisions for environmental watering by the Southern Connected Basin Environmental Watering Committee (SCBEWC) where relevant.

The water resource plan for Northern Victoria (DELWP, 2020) was accredited by the MDBA in June 2020. Water resource plans are a state obligation under the Basin Plan that must set out arrangements for the sustainable use, management and monitoring of water resources in the water resource plan area, and include planning for environmental water, indigenous values and uses and the broad approaches to the way risks to the water resources should be addressed. Water resource plans are a key driver in implementing the outcomes of the Basin Plan at both a local and Basin-wide level.

This first update to the Northern Victoria LTWP is required under Basin Plan due to the accreditation of the water resource plan for Northern Victoria. The aim of this update is to ensure alignment with the water resource plan for Northern Victoria and does not make substantive change to the document. A further update is planned, following the next planned update by the MDBA of the Basin-wide environmental watering strategy in 2023 (Figure 3).

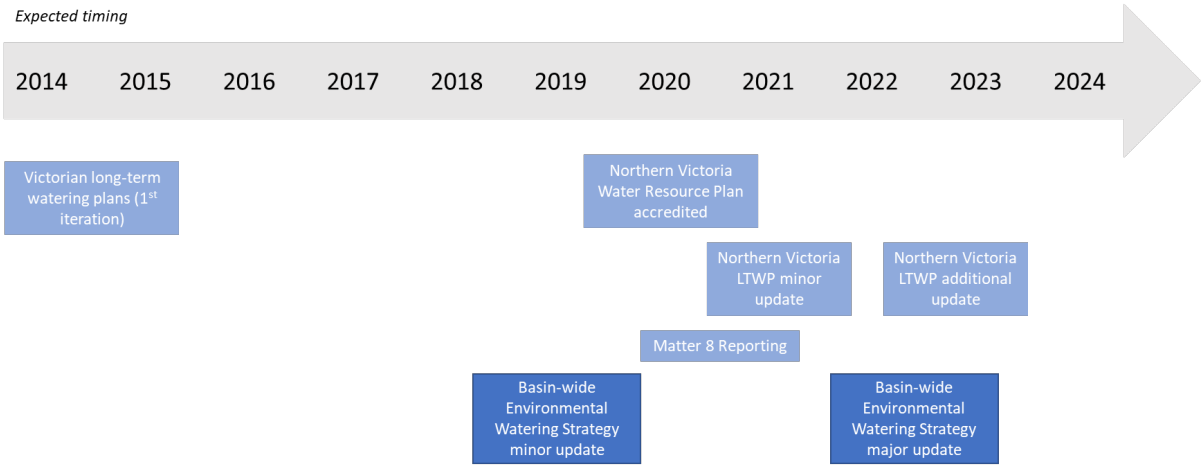


Figure 3: Victoria's long-term environmental water planning process in the context of other planning and strategic documents

1.4 Basin-wide environmental watering strategy

The Basin-wide environmental watering strategy (BWS) (MDBA, 2019) was first published by the MDBA in 2014, and updated in November 2019. Its purpose is to assist environmental water managers to plan and manage environmental watering at the Basin scale. The BWS identifies expected environmental outcomes grouped under four ecological 'themes'; river flows and connectivity, native vegetation, waterbirds and fish. BWS expected environmental outcomes relevant to Victoria are listed in Appendix K. Alignment of LTWP objectives to the BWS expected environmental outcomes is shown in Section 3.3.

As well as having regard to the BWS during preparation, LTWPs must also be consistent with any particular assets or functions, and their requirements, identified within the BWS. Assets considered important for supporting vegetation, waterbirds and fish at the Basin-scale are identified in the BWS; those assets listed in the North and Murray Water Resource Plan are listed in Section 2.4.

1.5 Division 6 principles

The Basin Plan sets out eleven principles to be applied in environmental watering and requires Basin states to have regard to them when developing long-term watering plans. Alignment with Division 6 principles is addressed in Appendix A.

1.6 Victorian frameworks

1.6.1 Entitlement framework

Environmental water in Victoria is defined and protected as the Environmental Water Reserve under the *Water Act 1989 (Vic)* and is provided in three ways:

- **Environmental water entitlements**: a proportion of water held by the environment in perpetuity. In general, the entitlements are a share of the available resource (inflows) in storages that can be released to meet specific environmental needs.
- **Obligations on consumptive entitlements**: the volume of water that water corporations or licensed diverters are obliged to provide out of storage or past a diversion point before water can be taken for consumptive use.
- '**Above cap' water**: the water available above limits on consumptive volumes of surface water and groundwater. Most water available to the environment is 'above cap' water, which can be a very unreliable source of water.

In regulated systems, environmental water is set aside mainly through environmental water entitlements. In unregulated rivers, environmental water is provided primarily through management of existing diversions via license conditions, rostering and restriction rules.

Section 4 provides further details on the provision of environmental water in Victoria, including explanations of held and planned environmental water. More information is also provided in Victoria's North and Murray Water Resource Plan (DELWP, 2020)

1.6.2 Waterway management framework

State Strategy

The state policy for the environmental management of waterways is documented in the Victorian Waterway Management Strategy (VWMS) (DEPI, 2013b). The VWMS outlines the overarching policy for environmental management of Victorian waterways and how existing programs of management support this policy. It establishes integrated, devolved decision making. The VWMS aims to maintain or improve the environmental condition of waterways to support environmental, social, cultural and economic values.

The VWMS documents policies and actions for major waterway management issues including environmental water management, riparian management, water quality, the river channel, wetlands and invasive species management in waterways. It acknowledges that co-dependencies exist between all management areas in maintaining or improving outcomes for waterway health. The VWMS is currently being reviewed and an updated version is expected to be released in 2023.

The Victorian Waterway Management Program is based on an eight-year adaptive management cycle (five-year cycle for Melbourne Water), where learning occurs at all stages and is used to update and improve the program in subsequent cycles. It comprises three main phases:

- Strategy and planning.
- Implementation and monitoring.
- Evaluation and reporting.

Community participation and research and innovation occur across all parts of the Program. The Program is a partnership between state government, regional agencies and authorities, other management partners (such as Traditional Owners) and local communities. As part of the program, DELWP is responsible for establishing the state policy framework for waterway management. Regional implementation is led by waterway managers from our nine catchment management authorities and Melbourne Water in the Port Phillip and Westernport region.

Regional Strategies

In northern Victoria, CMAs[3] are nominated as regional waterway managers under Part 10 of the *Water Act 1989* (Vic).

CMAs have established Regional Catchment Strategies that are the primary integrated planning framework for land, water and biodiversity management in each region in Victoria, providing an overarching strategic framework for actions. CMAs have also prepared Regional Waterway Strategies that identify, in consultation with local communities, the regional priorities for on-ground works and environmental water based on the **values** (environmental, social, cultural, economic), **threats**, and **condition**.

In the Northern Victoria water resource plan area, the relevant CMAs and their Regional Waterway Strategies are:

- North Central; North Central CMA Waterway Strategy 2014-22 (NCCMA, 2014)
- Goulburn Broken; Goulburn Broken Waterway Strategy 2014-2022 (GBCMA, 2014).
- North East; North East Waterway Strategy (NECMA, 2014).

Regional Waterway Strategies are currently being reviewed and will be updated in 2023.

1.6.3 Environmental water framework

Of the waterway management issues outlined in the VWMS, environmental water plays a significant role in waterway health. River regulation and licenced surface and groundwater use across Victoria has reduced the amount of water available and affected the hydrological regimes required to support environmental values.

To provide more appropriate water regimes for the environment, the adaptive management cycle is applied and includes:

- Ensuring environmental water needs are understood.
- Ensuring environmental water is protected – this includes having appropriate policy and legislation in place.
- Ensuring the water regime is managed to meet environmental objectives (planning and delivering water for the environment).
- Overcoming physical or operational constraints to enable best use of the water and maximise outcomes for the environment.
- Monitoring outcomes to evaluate whether objectives are being achieved and to inform adaptive management
- Reviewing the process to adapt and improve as required.

Necessary to support these are:

3. In the Port Phillip and Westernport region Melbourne Water is the designated waterway manager. In every other region in Victoria CMAs are the designated waterway managers.

- Clear roles and responsibilities.
- Management of risks relating to environmental water.
- Adequate research to support environmental watering knowledge.
- Appropriate investment at each stage.

1.6.4 Environmental water planning, prioritisation and delivery

Using the State and regional strategies as a basis, waterway managers (CMAs in northern Victoria) and the Victorian Environmental Water Holder (VEWH) undertake detailed and adaptable planning for environmental water at both the long-term and annual scales. Figure 4 presents the environmental water planning and delivery framework in Victoria. This includes legislation at the national and state levels, state and regional waterway strategies, development of EWMPs and annual Seasonal Watering Proposals by CMAs, and the state-wide Seasonal Watering Plan released by the VEWH each year.

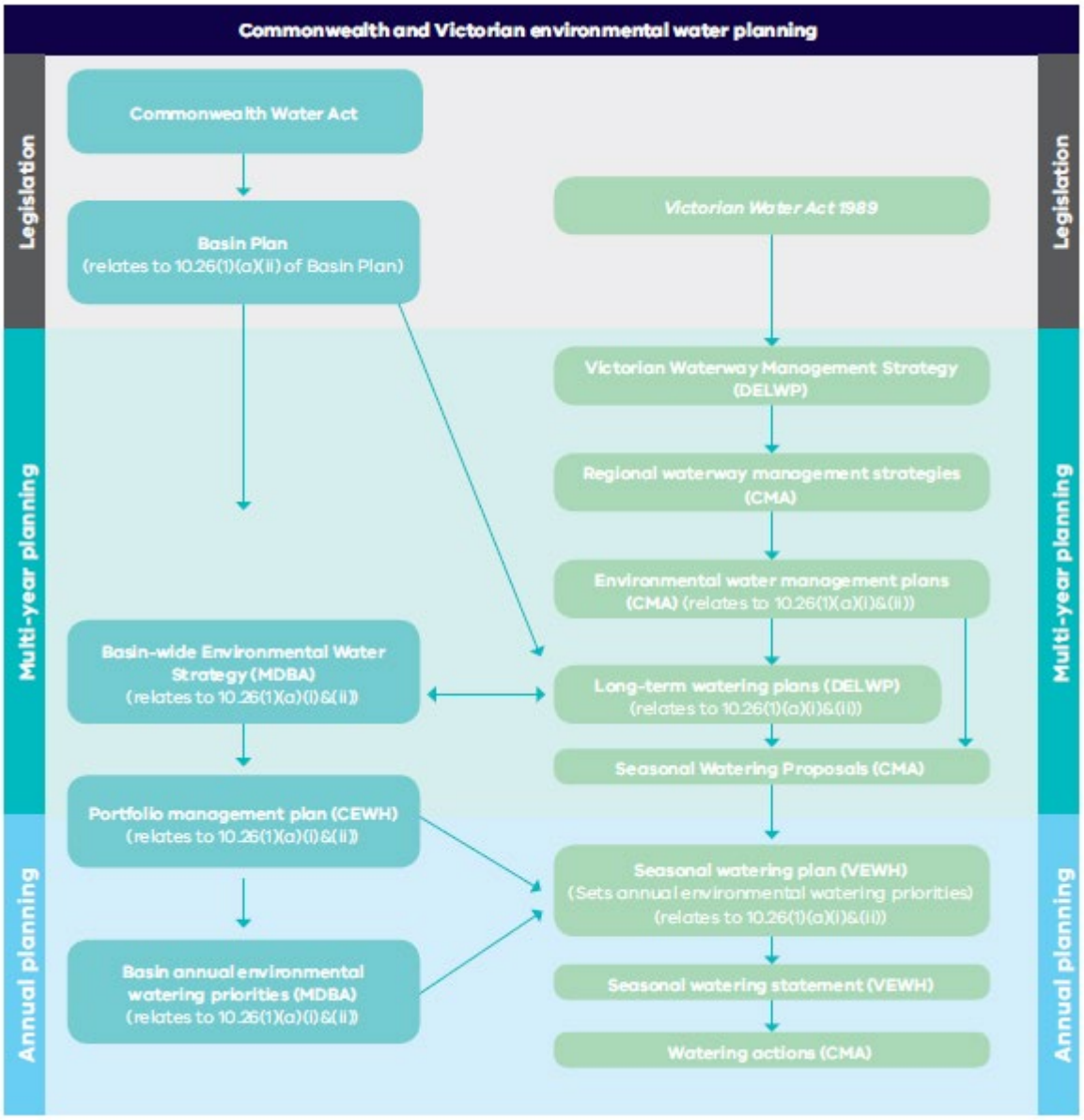


Figure 4: Environmental water planning and delivery framework in Victoria – Basin, State and Regional scales (Basin Plan specific components referred to above are described in Basin Plan Part 6, section 10.26)

The VEWH's Seasonal Watering Plan identifies priority watering actions across the state by applying criteria that include extent of environmental benefit, certainty of achieving environmental benefit, water requirements of a site, feasibility of the watering action and overall cost effectiveness (Figure 5).

Figure 5: VEWH Criteria for prioritising environmental watering actions

1.6.5 Seasonally adaptive approach

Victoria uses a 'seasonally adaptive' approach to identify annual watering actions, along with complementary works and measures, recognising that achieving objectives may require more than just delivering water (Table 1). It is a flexible way to deal with short-term climatic variability and helps to guide annual priorities and manage droughts, depending on the amount of water available in a particular year. This approach recognises that it will take time to realise the ecological outcomes associated with the BWS and the objectives outlined in the Basin Plan. For example, increasing the abundance and diversity of native fish populations is likely to require successful recruitment over multiple years, depending on such things as the life history of the target species, availability and quality of habitat (including refuge habitat during dry periods), and the opportunity for fish to migrate and spawn.

Table 1: Victorian seasonally adaptive approach to river and wetland management

	Drought	Dry	Average	Wet to very wet
Long-term ecological objectives	Long-term objectives to move towards ecologically healthy rivers - set through the Victorian and regional waterway management strategies			
Short-term ecological objectives	• Priority sites have avoided irreversible losses and have capacity for recovery	• Priority river reaches and wetlands have maintained their basic functions	• The ecological health of priority river reaches and wetlands has been maintained or improved	• The health and resilience of priority river reaches and wetlands has been improved
Annual management objectives	• Avoid critical loss • Maintain key refuges • Avoid catastrophic events	• Maintain river functioning with reduced reproductive capacity • Maintain key functions of high priority wetlands • Manage within dry-spell tolerances	• Improve ecological health and resilience	• Maximise recruitment opportunities for key river and wetland species • Restore key floodplain linkages
Environmental water reserve	• Water critical refuges • Undertake emergency watering to avoid catastrophic events • Provide carryover (for critical environmental needs the following year) • If necessary, use the market to purchase water • Dry inflow contingency planning???	• In priority river reaches provide summer and winter baseflows • Water high priority wetlands • Provide river flushes where required to break critical dry spells • Provide carryover (for critical environmental needs the following year) • If necessary, use the market to sell or purchase water	• Provide all aspects of the flow regime • Provide sufficient flows to promote breeding and recovery • Provide carryover to accrue water for large watering events • If necessary, use the market to sell or purchase water	• Provide overbank flow • Provide flows needed to promote breeding and recovery • If necessary, use the market to sell or purchase water
River and wetland catchment activities	• Protect refuges (including stock exclusion) • Increase awareness of the importance of refuges • Enhanced monitoring of high risk areas and contingency plans in place • Investigate feasibility of translocations • Environmental emergency	• Protect refuges • Protect high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Environmental emergency management plans in place	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works. • Monitor and survey river and wetland condition • Improve connectivity between rivers and floodplain wetlands.	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works. • Monitor and survey river and wetland condition

	Drought	Dry	Average	Wet to very wet
	management plans in place • Protect high priority river reaches and wetlands through fencing; pest, plant and animal management; and water quality improvement works • Implement post-bushfire river recovery plans	• Improve connectivity • Implement post-bushfire river recovery plans		• Emergency flood management plans in place • Implementation of post flood river restoration programs

1.6.6 Delivery partners

Several organisations work together to deliver environmental water outcomes in Victoria. These organisations and their roles are described in the Cooperative Arrangements section of this plan (Section 5).

1.6.7 Shared benefits

Shared benefits are additional opportunistic benefits that can be achieved from environmental watering, including social, cultural, recreational and economic benefits. While the primary purpose of environmental watering is to achieve ecological outcomes, under the *Water and Catchments Amendment Bill 2019* environmental water managers are also required to consider whether shared benefits can be achieved when planning for watering events, this includes incorporation of recreational and Aboriginal values into the planning and management of waterways and catchments. However, the use of environmental water to provide for specific social, cultural, recreational, economic and/or Traditional Owner benefits cannot be prioritised at the expense of achieving environmental objectives.

Waterway managers work with communities to identify the environmental, social, cultural and economic values of waterways through Regional Waterway Strategies, EWMPs and seasonal watering proposals. Environmental water managers will continue to work with stakeholders to achieve shared benefits from environmental watering, as per the engagement principles outlined in Chapter 6 of the VWMS. More information on shared benefits is provided in Section 4 of this plan and in Chapter 12 of the Victoria's North and Murray Water Resource Plan (DELWP, 2020).

2. Water resource plan area – priority environmental assets and ecosystem functions

The Northern Victoria water resource plan area extends from the Victorian Alps in the east, to Ballarat in the south and west of the Loddon River. This water resource plan area region is dominated by northerly flowing river systems connected to the River Murray. It contains sections of the Victorian CMA regions of North Central, Goulburn Broken and North East.

2.1 Features of the Northern Victoria water resource plan area

The Northern Victoria water resource plan area (Figure 6) comprises the major tributaries of the River Murray downstream of the junction with the Kiewa River. The water resource plan area is dominated by northerly flowing river systems connected to the River Murray. It includes the Ovens, Goulburn-Broken, Campaspe, and Loddon (upstream of Kerang) Rivers, with associated wetlands in the Loddon, Goulburn and Ovens catchments. The lower Loddon River and wetlands associated with the River Murray (e.g. Barmah Forest) lie in the Victorian Murray water resource plan area immediately to the north of this water resource plan area.

Most of the major rivers are highly regulated (refer to Section 2.1.4) by the presence and operation of the region's major water storages and weirs. Major storages include Cairn Curran, Tullaroop and Laanecoorie Reservoirs on the Loddon River, Lake Eppalock on the Campaspe River, the Upper Coliban storages on the Coliban River, Lake Eildon and Goulburn Weir on the Goulburn River, Lake Nillahcootie on the Broken River, and Lake Buffalo and Lake William Hovell on the Ovens River system.

2.1.1 Topography

The highest point in the water resource plan area (Mt Feathertop) is located near the headwaters of the Ovens River and is 1922 m above sea level while Kerang has an elevation of 77 m metres above sea level. The eastern and southern extents of the water resource plan area are dominated by land that is steep and relatively high relief (over 500 m AHD). However, the majority of the water resource plan area is dominated by lowland rivers (generally under 200 m AHD) (ABS, 2012). Figure 7 presents the (relative) topography in the Northern Victoria water resource plan area.

2.1.2 Geology, soils and land use

The geology of the plains in northern Victoria are complex and comprise unnamed alluvium along the northern reaches of the Campaspe, Loddon, Goulburn and Broken rivers and associated floodplains. Along the Great Dividing Range, the geology is a combination mainly sandstones and siltstones (e.g. Castlemaine Group, Adaminaby Group, Norton Gully Sandstone, Humevale Siltstone) and Late Devonian granitic rocks.

This region is often referred to as the 'food bowl of Victoria', in recognition of its major land use being production and having high agricultural productivity. In 2005-2006, the Goulburn Murray Irrigation District accounted for just under 25% of the value of Victoria's agricultural production (GMW, 2015).

The land use is a combination of irrigation through lowland floodplains of the northern region, grazing in the mid to upper catchments in the south, with some forestry operations in the foothills (NCCMA, 2013).

2.1.3 Rainfall distribution

The climate of the Northern Victoria water resource plan area is highly variable across the whole region. The average annual rainfall ranges from up to 2000 mm in the Victorian Alps in the east to less than 400 mm near Kerang. This rainfall is generally evenly distributed throughout the year (BoM, 2015).

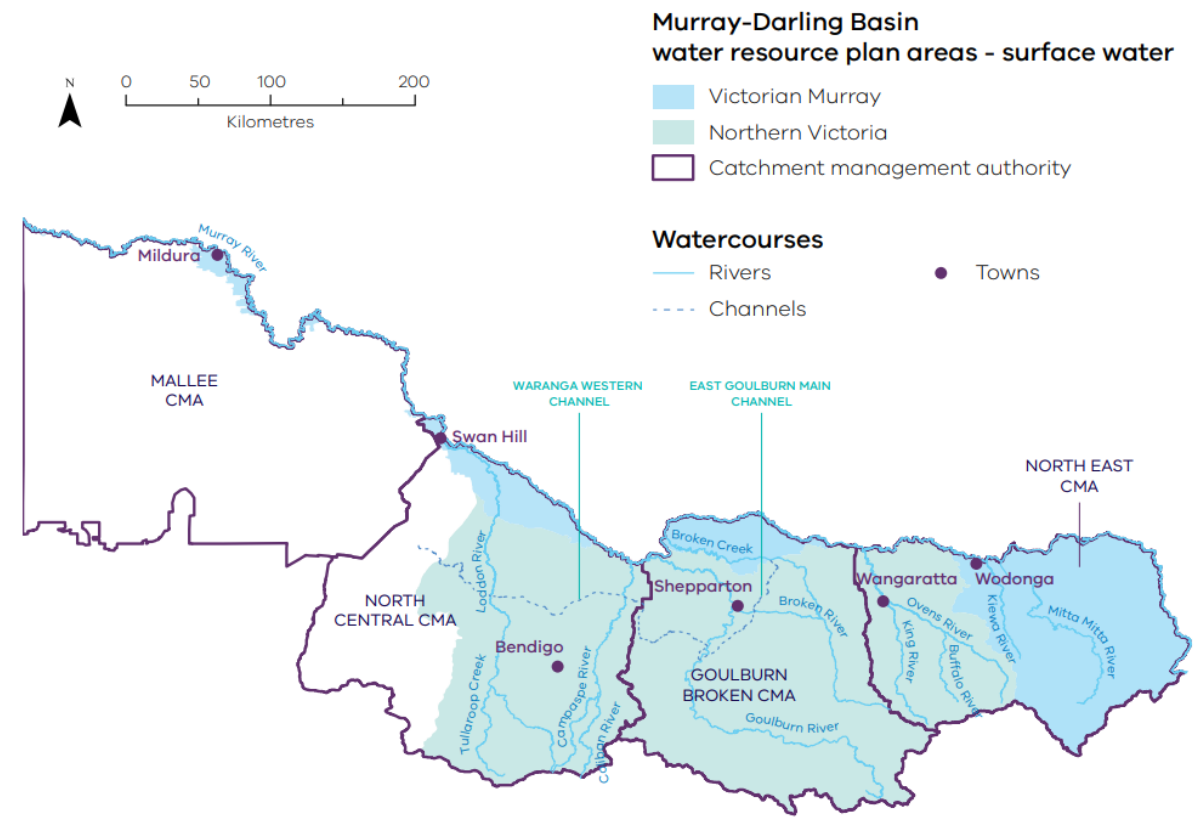


Figure 6: Northern Victoria water resource plan area showing catchment management authority boundaries. The Victorian Murray water resource plan area is also shown

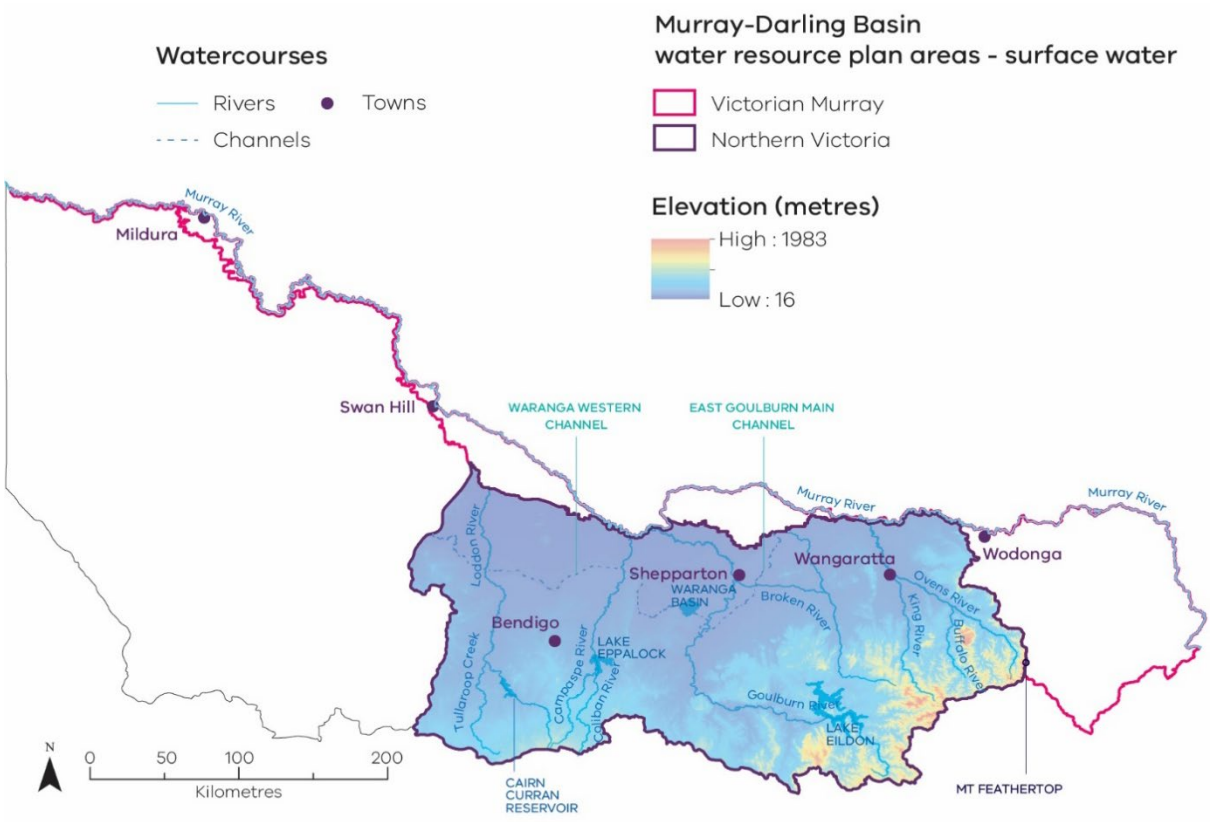


Figure 7: Topography in the Northern Victoria water resource plan area

2.1.4 Working rivers

The rivers of this water resource plan area provide for environmental, economic, cultural and social outcomes. As such the rivers have been modified to varying extents from their natural state. The modifications have impacted on the hydrologic regime, physical form, riparian vegetation, water quality

and instream ecology. It is not intended that these streams be restored to a pre-development state, but that they be managed as 'working rivers' with agreed sustainable levels of modification and use, which may include improvements in ecological values and functions.

2.2 Representativeness

An objective of the Basin Plan is to protect and restore a subset of all water-dependent ecosystems of the Murray-Darling Basin, and to support biodiversity by ensuring representative populations, communities and species are protected, and where necessary restored. The CEWH, for example, has used the Australian National Aquatic Ecosystems (ANAE) classification framework to define the distinct waterway types and their location in the Basin (Brooks, 2017). This provided the basis for assessing the waterway types across the Basin that have received CEWH environmental water e.g. (Hale J., 2020).

Victoria has undertaken a similar representativeness assessment with the waterway type of each priority environmental asset in the Basin Plan area (see Section 2.4). Each asset has been classified using the ANAE framework and compared to the total area of the relevant waterway type(s) at two different scales, for the entire Basin Plan area in northern Victoria and also for each water resource plan area (Brooks, 2019). Broadly, most waterway types present in northern Victoria are represented by existing priority environmental assets. Some waterway types are well represented, in particular river red gum swamps and black box woodland riparian zones, while others including clay pans, river red gum floodplains and mixed woodland floodplains are less well represented. Some of the sparsely represented types tend to be disconnected from water delivery channels or may occur at higher elevations and, as such, be difficult to water. Others, such as clay pans may be considered to have low ecological value and hence not be a priority for environmental water. Yet others (e.g. saltmarshes), would be damaged by addition of freshwater.

Twelve of the 34 ANAE wetland types recorded across the Northern Victoria water resource plan area are represented as priority ecosystem assets (Table). Based on the relative proportion of wetland area compared with that for each ANAE type across Northern Victoria, five types are over-represented (Temporary river red gum swamp, Permanent lake, Freshwater meadow, Permanent wetland, Temporary sedge/grass/forb marsh), while priority ecosystem assets consisting of three ANAE types are under-represented (Woodland riparian zone or floodplain, River red gum woodland riparian zone or floodplain, Clay pan). The under-represented ANAE types are mainly floodplain and claypan systems that do not normally receive environmental water.

Eight ANAE river types are present across the Northern Victoria water resource plan area (Table). Based on the relative length of each ANAE river type, three ANAE river types are under-represented as priority ecosystem assets (Temporary transitional zone stream, Temporary high energy upland stream, Temporary lowland stream), while one river type is under-represented (Permanent lowland stream).

Table 2: Representativeness* of wetland priority environmental asset types compared with Northern Victoria water resource plan area ANAE waterway types

ANAE Type	Northern Victoria WRPA		Northern Victoria priority environmental assets		Difference	Representation in WRPA
	Area (ha)	%Are	Area (ha)	% Area		
Pt1.1.2: Temporary river red gum swamp	9071.7	4.9	410.2	20.2	+15.3%	Over
Lp1.1: Permanent lake	7316.4	3.9	274.9	13.6	+9.7%	Over
Pt2.3.2: Freshwater meadow	5864.2	3.2	706.9	34.9	+31.7%	Over
Pt1.7.2: Temporary lignum swamp	4473.3	2.4	82.9	4.1	+1.7%	Similar
Pp4.2: Permanent wetland	1730.1	0.9	214.1	10.6	+9.7%	Over
Pt2.2.2: Temporary sedge/grass/forb marsh	317.8	0.2	133.2	6.6	+6.4%	Over
F1.12: Woodland riparian zone or floodplain	44404.5	23.9	36.0	1.8	-22.1%	Under
F1.4: River red gum woodland riparian zone or floodplain	42387.3	22.8	14.4	0.7	-22.1%	Under
Pt3.1.2: Clay pan	27761.5	15.0	Not represented	-	-15.0%	Under
Pst3.2: Salt pan or salt flat	64.4	<0.1	Not represented	-	-0.1 to 0%	Similar
F2.2: Lignum shrubland riparian zone or floodplain	6983.7	3.8	Not represented	-	-3.8%	Similar
F1.8: Black box woodland riparian zone or floodplain	6723.6	3.6	Not represented	-	-3.6%	Similar
Rp1.4: Permanent lowland stream	5817.4	3.1	15.1	0.7	-2.4%	Similar
Pt1.6.2: Temporary woodland swamp	3767.0	2.0	8.5	0.4	-1.6%	Similar
Rt1.4: Temporary lowland stream	2748.4	1.5	Not represented	-	-1.5%	Similar
Lt1.1: Temporary lake	2314.9	1.2	Not represented	-	-1.2%	Similar
Pt1.2.2: Temporary black box swamp	2051.5	1.1	Not represented	-	-1.1%	Similar
Pt2.1.2: Temporary tall emergent marsh	1060.5	0.6	Not represented	-	-0.6%	Similar
Pp2.4.2: Permanent forb marsh	570.8	0.3	Not represented	-	-0.3%	Similar

ANAE Type	Northern Victoria WRPA		Northern Victoria priority environmental assets		Difference	Representation in WRPA
	Area (ha)	%Are	Area (ha)	% Area		
Pt4.1: Floodplain or riparian wetland	470.3	0.3	Not represented	-	-0.3%	Similar
Pst1.1: Temporary saline swamp	404.8	0.2	Not represented	-	-0.2%	Similar
Lst1.2: Temporary saline lake with aquatic bed	238.1	0.1	Not represented	-	-0.1%	Similar
Pt4.2: Temporary wetland	173.6	0.1	Not represented	-	-0.1%	Similar
Lst1.1: Temporary saline lake	173.5	0.1	Not represented	-	-0.1%	Similar
F2.4: Shrubland riparian zone or floodplain	139.0	0.1	Not represented	-	-0.1%	Similar
Pt1.8.2: Temporary shrub swamp	111.5	0.1	Not represented	-	-0.1%	Similar
F1.2: River red gum forest riparian zone or floodplain	8256.0	4.4	88.6	4.4	0.0%	Similar
Lt1.2: Temporary lake with aquatic bed	54.8	<0.1	Not represented	-	0.1 to 0%	Similar
Pp2.1.2: Permanent tall emergent marsh	52.4	<0.1	Not represented	-	0.1 to 0%	Similar
Lsp1.1: Permanent saline lake	46.4	<0.1	Not represented	-	0.1 to 0%	Similar
F1.6: Black box forest riparian zone or floodplain	28.9	<0.1	Not represented	-	0.1 to 0%	Similar
Pst4: Temporary saline wetland	23.8	<0.1	Not represented	-	0.1 to 0%	Similar
Rp1: Permanent stream	8.7	<0.1	Not represented	-	0.1 to 0%	Similar
Pps5: Permanent spring	5.1	<0.1	Not represented	-	0.1 to 0%	Similar

*Over- or under- representation is based on a $\pm$ 5% deviation of the relative proportion of the priority environmental asset area for a particular ANAE type to the total priority environmental asset area, compared with that of the ANAE type for the whole Northern Victoria WRPA (adapted from (Brooks, 2019). ANAE is the Australian National Aquatic Ecosystems (ANAE) classification framework.

Table 3: Representativeness* of riverine priority environmental assets compared with Northern Victoria ANAE waterway type

ANAE Type	Northern Victoria WRPA		Northern Victoria priority environmental assets		Difference	Representation in WRPA
	Length (km)	%Length	Length (km)	%Length		
Rt1.2: Temporary transitional zone stream	15076.8	43.5	38.5	2.4	-41.1%	Under
Rt1.1: Temporary high energy upland stream	8628.8	24.9	14.5	0.9	-24.0%	Under
Rt1.4: Temporary lowland stream	7878.1	22.7	88.9	5.6	-17.2%	Under
Rp1.4: Permanent lowland stream	2072.9	6.0	1361.0	85.2	79.2%	Over
Rp1.2: Permanent transitional zone stream	664.5	1.9	78.8	4.9	3.0%	Similar
Rp1.1: Permanent high energy upland stream	202.0	0.6	0.7	0.0	-0.5%	Similar
Rt1.3: Temporary low energy upland stream	97.8	0.3	4.3	0.3	0.0%	Similar
Rp1.3: Permanent low energy upland stream	28.8	0.1	Not represented	-	-0.1%	Similar

*Over- or under- representation is based on a ± 5% deviation of the proportion of the riverine priority environmental asset length for a particular ANAE type to the total priority environmental asset length, compared with that of the ANAE type for the whole Northern Victoria WRPA (adapted from **(Brooks, 2019)**.

2.3 Significant ecological values of the Northern Victoria water resource plan area[4]

The priority environmental assets of the Northern Victoria water resource plan area support ecological values that are significant at the National and State level. The information below focuses on the priority environmental assets where held environmental water can be managed to deliver specific environmental outcomes. Note: several Ramsar sites occur in the Goulburn Broken, North Central and Mallee CMA areas (Barmah Forest, Gunbower Forest, Kerang Wetlands, Hattah-Kulkyne Lakes). However, water delivery to these sites occurs through the River Murray system, and so are included as significant ecological systems in the Victorian Murray LTWP, rather than in this LTWP.

Significant water-dependent ecological values in the Northern Victoria water resource plan area are shown in Figure , in alignment with themes set out in the Basin-wide environmental watering strategy (MDBA, 2019).

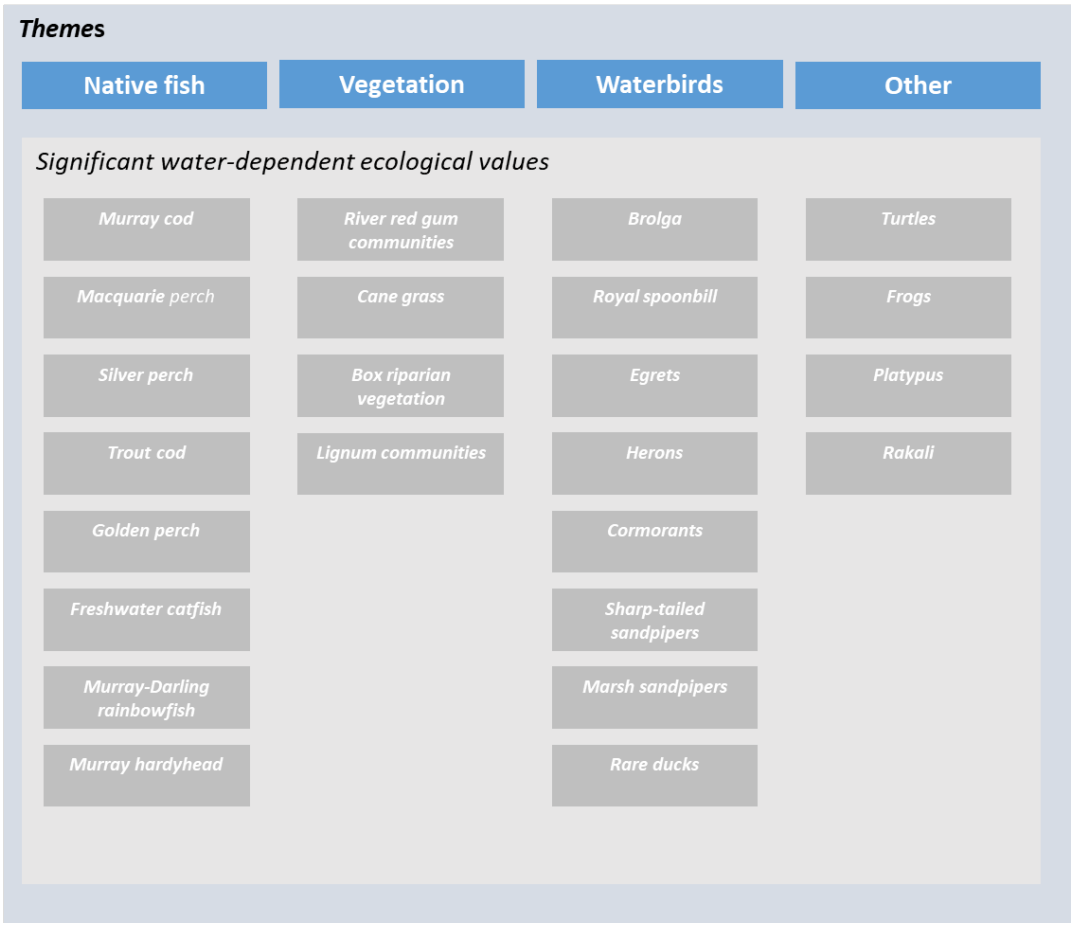


Figure 8: Significant water-dependent ecological values in the Northern Victoria water resource plan area

2.3.1 Ovens River catchment

The Ovens River priority asset includes the regulated reaches - the Buffalo River below Lake Buffalo, the King River below Lake William Hovell and the Ovens River from its confluence with the Buffalo River to Lake Mulwala. The catchment upstream of the Buffalo River is unregulated and so the flow regime is not as severely affected as other regulated rivers in the State. The most recent Index of Stream Condition results indicate that much of the Ovens system is in moderate environmental condition (DEPI, 2013c).

The diverse aquatic habitat and abundant food resources associated with the Ovens system support a wide range of native fish species including Murray cod, trout cod, golden perch and unspecked hardyhead, many of which are recognised for their conservation significance (Table Table 4). The

[4] Sourced from the Seasonal Watering Plan 2020-21 (VEWH, 2020) produced by the Victorian Environmental Water Holder.

Buffalo River provides valuable habitat for large-bodied fish species during part of their breeding cycle, while trout cod have a large range within the system and are found as far up the King River as Whitfield. A project to recover trout cod populations in the Ovens system has been successful, and efforts to reintroduce Macquarie perch are continuing (VEWH, 2020).

Frogs (such as the giant banjo frog and growling grass frog) are abundant in the lower reaches and associated wetlands of the Ovens River and in the King River above Cheshunt. The streamside zones of river channels throughout the Ovens system support some of Victoria's healthiest river red gum forests and woodlands, while the wetlands support a variety of aquatic and semi-aquatic vegetation communities.

Table 4: Significant native fish in the Northern Victoria water resource plan area

Common name	Scientific name	Conservation significance[5]
Murray cod	*Maccullochello peeli peeli*	Vulnerable (EPBC Act) FFG list Vulnerable (Victoria)
Macquarie perch	*Macquaria australasica*	Endangered (EPBC Act) FFG list Endangered (Victoria)
Silver perch	*Bidyanus bidyanus*	FFG list Vulnerable (Victoria)
Trout cod	*Maccullochella macquariensis*	Endangered (EPBC Act) FFG list Critically Endangered (Victoria)
Golden perch	*Macquaria ambigua*	Near Threatened (Victoria)
Freshwater catfish	*Tandanus tandanus*	FFG list Endangered (Victoria)

2.3.2 Goulburn and Broken River catchments

The Goulburn and Broken Rivers support a range of native fish, including golden perch, silver perch, Murray cod, trout cod, Macquarie perch and freshwater catfish. Its aquatic vegetation and submerged logs provide great diversity of habitat to support adult and juvenile fish. The bank vegetation is dominated by river red gum open forest/woodland, and yellow box and grey box woodland/open forest communities which provide significant habitat for vulnerable or threatened wildlife (e.g. barking marsh frog). Birds such as egrets, herons and cormorants regularly use the river to feed.

The Goulburn River downstream of Lake Eildon is a state Heritage River, and the lower river floodplain (which includes Reedy Swamp) is listed in the Directory of Important Wetlands. The most recent Index of Stream Condition results indicate the majority of the Goulburn Broken system to be in moderate environmental condition; however, sections of the Broken Creek are in poor condition, and sections of the Broken River in very poor condition (DEPI, 2013c).

Reedy Swamp, Doctors Swamp and Moodie Swamp contain a wide variety of vegetation communities including river red gum dominated EVCs, Tall Marsh, Floodway Pond Herbland, Rushy Riverine Swamp, and Cane Grass Wetlands. Reedy Swamp is an important colonial nesting waterbird breeding site and an important site for migratory birds. Moodie Swamp contains several state and nationally threatened species and communities, including rigid water milfoil, slender water milfoil and river swamp wallaby-grass. The wetlands provide breeding habitat for several bird species (such as the brolga and royal spoonbill) listed in international agreements and conventions.

2.3.3 Campaspe River catchment

The Campaspe River (downstream of Lake Eppalock) contains habitat for several significant fish species including Murray cod, silver perch, golden perch and Murray-Darling rainbowfish. Platypus,

[5] DSE (2013) *Advisory List of Threatened Vertebrate Fauna in Victoria*. Department of Conservation and Environment, Melbourne.

turtles and frogs also inhabit the river. Along the river, there is a highly-connected, intact river red gum canopy. Index of Stream Condition results indicate the Campaspe River below Lake Eppalock to be in good to moderate environmental condition (DEPI, 2013c).

The Coliban River previously retained populations of Murray cod, trout cod, golden perch, river blackfish and Macquarie perch. However, there have been no survey or angler reports of these species in recent years. Platypus, rakali and common long-necked tortoises have also been recorded, with recent surveys indicating a relatively large breeding population of platypus (*Darren White, NC CMA, pers. comm.*). The river supports stands of emergent and submerged aquatic vegetation, while the riparian environment is dominated by remnant patches of stream bank. Similar to the Campaspe, Index of Stream Condition results indicate the Coliban River to be in moderate environmental condition (DEPI, 2013c).

2.3.4 Loddon River catchment

The Loddon River catchment includes the Loddon River downstream of Cairn Curran Reservoir to Kerang, Tullaroop Creek downstream of Tullaroop Reservoir, and Birch's Creek downstream of Newlyn Reservoir. Tullaroop Creek and the Loddon River contain populations of Murray cod, golden perch and river blackfish. Riparian vegetation is typically narrow river red gum woodland in the upper section (LREFSP, 2002), with some shrubby understorey of Lignum further downstream. Index of Stream Condition results indicate the Loddon River to be in moderate environmental condition, Tullaroop and Birch's Creeks in poor condition, and Pyramid, Serpentine and Bullock Creeks to be in very poor condition (DEPI, 2013c).

The Boort wetlands (Boort, Leaghur, Meran and Yando lakes) contain important habitat for a range of bird, reptile and amphibian species. The wetlands are extremely productive for waterbird use and breeding, including yellow-billed spoonbill, banded stilt, Australian white ibis, and a number of duck species. Significant fish species recorded include Murray hardyhead and freshwater catfish.

Native vegetation values in the wetlands include several threatened ecological vegetation types such as Red Gum Swamp and Riverine Chenopod Woodland, and important plant species such as cane grass.

2.4 Priority environmental assets within the Northern Victoria water resource plan area

Priority environmental assets listed in this LTWP (Table) are water-dependent ecosystems that can be managed with environmental water and meet one or more of the criteria listed in Basin Plan Schedule 8 (see Glossary). An asset may be a single wetland or waterbody (e.g. Mansfield Swamp), a wetland complex (e.g. Lake Meran complex), or a river/creek (e.g. Campaspe River). Asset locations are shown in Figure 9.

All of the sites listed are considered by Victoria to be priority assets in that they currently receive environmental water and meet criteria in Basin Plan schedule 8. Figure 6 shows the distribution of these priority assets in the Northern Victoria water resource plan area.

It is important to note that all of the priority rivers in Table 5 are regulated. These are the rivers that have held environmental water (HEW), this plan seeks to guide use of HEW to meet objectives and targets. There are also many unregulated rivers that are also important assets within the WPRA that have important environmental outcomes. However, in unregulated systems, there is no HEW to manage for specific environmental outcomes. The aim for unregulated rivers is to maintain existing arrangements such as conditions regulating the take of water through Bulk Entitlements and licences, see Section 4.4.

2.4.1 Changes to priority environmental assets since the previous LTWP

The list of priority environmental assets has been updated since the 2015 LTWP.

The Lower Ovens Wetland Complex has been removed as it is not considered to receive enough environmental water to justify its inclusion.

The Broken River and Upper Broken Creek have been separated from the Goulburn River asset and considered as individual assets. This is because the Upper Broken Creek receives water from the

Broken River, while the Lower Broken Creek and Nine Mile Creek receive water from the River Murray (thus the Lower Broken Creek and Nine Mile Creek are included in the Victorian Murray LTWP).

Several creeks and wetlands are being considered for inclusion as priority environmental assets in the next LTWP update[6]:

- **Horseshoe Lagoon** is one of the many Goulburn River associated wetlands that are highly significant for Taungurung. It is a culturally significant site for Taungurung women. Water for the environment was delivered to the site, outside Seymour, for the first time in July 2019. Celebrating the delivery Taungurung water knowledge group Baan Ganalina (Guardians of Water), Goulburn Broken CMA, local landholders and partners came together to mark the significant occasion. Horseshoe Lagoon vegetation comprises mainly of tall marsh, floodway pond herbland and floodplain streamside woodland.
- **Loch Garry** incorporates an old channel of the Goulburn River that provides deep, open-water habitat. The channel is surrounded by shallow, vegetated wetland depressions, red gum forest and sand ridges. It is an important site for waterbird feeding and roosting, and it is a drought refuge for eastern great egrets, musk ducks, nankeen night herons and royal spoonbills.
- **Kanyapella Basin** is a shallow freshwater marsh that is part of the ancestral Lake Kanyapella in the Goulburn system. It is known to have supported waterbirds, including breeding colonies of ibis, heron and cormorants, and species of conservation significance (eastern great egret, white-bellied sea eagle (GBCMA, 2012). It also supports plant species of conservation significance. Kanyapella is an important cultural site for Yorta Yorta people.
- **Mullinmur Wetland** is a deep freshwater marsh near Wangaratta next to the Ovens River. It has the only catfish population in North East Victoria; with plans to use the site as a catfish brood stock location for future reintroductions into the region. Southern pygmy perch (SPP) have also been translocated into the wetland. The wetland site is utilised by students from the adjacent Borinya Community Partnership School and Galen College as part of their curriculum.
- **Pyramid, Serpentine, Tullaroop and Twelve Mile Creeks** in the lower Loddon system support large-bodied fish (such as golden perch, Murray cod and silver perch) and are important corridors for fish migration between the Loddon and Murray systems.
- **Round Lake** is one of the Central Murray wetlands. These wetlands support numerous listed threatened species ranging from vulnerable to critically endangered including the Australasian bittern, Murray hardyhead, Australian painted snipe and growling grass frog. When the wetlands receive environmental water, they can attract prolific birdlife and provide feeding and breeding habitat for many threatened and endangered bird species (including the eastern great egret and white-bellied sea eagle) listed under legislation and international agreements.
- **Upper Broken Creek** is a distributary stream of the Broken River and has significant environmental values. It supports an array of aquatic fauna species including platypus, Common Long-necked turtle and the threatened Murray cod, golden perch, silver perch and Murray-Darling rainbowfish.

Some information for these additional assets is included in this minor LTWP update, but they have not yet been fully incorporated, for example their objectives are not collated into the LTWP objectives. Their further inclusion will be assessed for the next LTWP update following the next BWS update planned for 2023.

6. Some information on assets is sourced from the Seasonal Watering Plan 2020-21 (VEWH, 2020) produced by the Victorian Environmental Water Holder.

Table 5: Priority environmental assets in the Northern Victoria water resource plan area

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[2]	Asset characteristics
Loddon River Catchment				
Loddon River (Middle and Upper)	Loddon	North Central CMA	1 2 3 4 5	JAMBA, CAMBA, ROKAMBA, Bonn Convention Creekline Grassy Woodland – Endangered, EVC68 Floodplain Riparian Woodland – Endangered, EVC56 High instream woody habitat values - critical habitat component for River Blackfish Deep pools – critical drought refuge Provides connectivity to facilitate migration, movement and dispersal EPBC Act, FFG Act, DSE list Supports significant levels of native biodiversity
Birch's (Bullarook) Creek	Loddon	North Central CMA	2 4	Swampy Riparian Woodland – Endangered EVC83 Creekline Grassy Woodland – Endangered EVC68 EPBC Act, FFG Act, DSE list
Lake Boort	Loddon	North Central CMA	1 2 4 5	JAMBA, CAMBA, ROKAMBA Plains Woodland – Endangered, EVC68 EPBC Act, FFG Act, DSE list Supports significant levels of native biodiversity
Lake Leaghur	Loddon	North Central CMA	1 2 3 4 5	JAMBA, CAMBA, ROKAMBA, Bonn Convention Deep freshwater marsh Semi-arid woodland – Endangered, EVC97 High connectivity to Loddon River Important breeding habitat for birds EPBC Act, FFG Act, DSE list High biodiversity
Lake Meran complex (Lake Meran and Little Lake Meran)	Loddon	North Central CMA	1 2 3 4 5	JAMBA, CAMBA, Bonn Convention Intermediate Swampy Woodland – Vulnerable EVC813 Permanent, deep freshwater lake providing refuge during drought EPBC Act, FFG Act, DSE list High biodiversity

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[2]	Asset characteristics
Lake Yando	Loddon	North Central CMA	1	JAMBA, CAMBA, ROKAMBA, Bonn Convention
			2	Deep freshwater marsh
			3	Red Gum Swamp – Vulnerable, EVC292
			4	Riverine Chenopod Woodland - Vulnerable, EVC103
			5	High habitat diversity
				EPBC Act, FFG Act, DSE list
				High biodiversity
Pyramid Creek[1]	Loddon	North Central CMA	1	JAMBA, CAMBA, ROKAMBA, Bonn Convention
			2	High instream woody habitat values - critical habitat component for River Blackfish
			3	Deep pools – critical drought refuge
			4	Provides connectivity to facilitate migration, movement and dispersal
			5	EPBC Act, FFG Act, DSE list
				Supports significant levels of native biodiversity
				Endangered EVCs
Round Lake[1]	Loddon	North Central CMA	TBC	TBC
Serpentine Creek[1]	Loddon	North Central CMA	1	JAMBA, CAMBA, ROKAMBA, Bonn Convention
			2	High instream woody habitat values - critical habitat component for River Blackfish
			3	Deep pools – critical drought refuge
			4	Provides connectivity to facilitate migration, movement and dispersal
			5	EPBC Act, FFG Act, DSE list
				Supports significant levels of native biodiversity
				Endangered EVCs
Tullaroop Creek[1]	Loddon	North Central CMA	1	JAMBA, CAMBA, ROKAMBA, Bonn Convention
			2	High instream woody habitat values - critical habitat component for River Blackfish
			3	Deep pools – critical drought refuge
			4	Provides connectivity to facilitate migration, movement and dispersal
			5	EPBC Act, FFG Act, DSE list
				Supports significant levels of native biodiversity
				Endangered EVCs

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[2]	Asset characteristics
Twelve Mile Creek[1]	Loddon	North Central CMA	1 2 3 4 5	JAMBA, CAMBA, ROKAMBA, Bonn Convention High instream woody habitat values - critical habitat component for River Blackfish Deep pools – critical drought refuge Provides connectivity to facilitate migration, movement and dispersal EPBC Act, FFG Act, DSE list Supports significant levels of native biodiversity Endangered EVCs
Campaspe River catchment				
Campaspe River	Campaspe	North Central CMA	1 2 3 4 5	JAMBA, CAMBA Floodplain Riparian Woodland – Endangered, EVC56 Wetland Formation – Endangered, EVC74 Riverine Chenopod Woodland – EVC103 Grassy Riverine Forest – EVC106 Riverine Grassy Woodland – EVC295 Lignum Swampy Woodland – EVC823 Complex instream woody habitat Large deep pools – critical drought refuge Extensive slackwater areas – nursery habitat Provides connectivity to facilitate migration, movement and dispersal EPBC Act, FFG Act, DSE list Supports significant levels of native biodiversity
Coliban River	Campaspe	North Central CMA	1 2 3 4	JAMBA Plains Grassy Woodland – Endangered, EVC55 Creekline Grassy Woodland – Endangered, EVC68 Stream Bank Shrubland – Endangered, EVC851 Instream woody habitat Submerged vegetation Waterfalls and pools Provides connectivity to facilitate migration, movement and dispersal EPBC Act, FFG Act, DSE list
Goulburn-Broken River catchments				

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[2]	Asset characteristics
Broken River	Goulburn	Goulburn Broken CMA	2 3 4	Floodplain Riparian Woodland – Endangered, EVC 56 Instream woody habitat Riffles and pools Large deep pools – critical drought refuge Extensive slackwater areas – nursery habitat Provides connectivity to facilitate migration, movement and dispersal High diversity of aquatic environments EPBC Act, FFG Act, DSE list
Upper Broken Creek[1]	Goulburn	Goulburn Broken CMA	3 4 5	Floodplain Riparian Woodland – Endangered, EVC 56 Creekline Grassy Woodland – Endangered, EVC68 Plains Grassy Woodland – Endangered, EVC55 Riverine Swampy Woodland – Endangered, EVC1099 Complex instream woody habitat Extensive slackwater areas – nursery habitat Provides connectivity to facilitate migration, movement and dispersal EPBC Act, FFG Act, DSE list High diversity of aquatic environments
Goulburn River	Goulburn	Goulburn Broken CMA	1 2 3 4 5	Floodplain Riparian Woodland – Endangered, EVC 56 Creekline Grassy Woodland – Endangered, EVC68 Wetland Formation – Endangered, EVC74 Plains Grassy Woodland – Endangered, EVC55 Drainage Line Aggregate – EVC168/EVC1022 Riverine Grassy Woodland – Endangered, EVC1040 Riverine Swampy Woodland – Endangered, EVC1099 Mid-Goulburn – heritage listed Complex instream woody habitat Large deep pools – critical drought refuge Extensive slackwater areas – nursery habitat Provides connectivity to facilitate migration, movement and dispersal EPBC Act, FFG Act, DSE list High diversity of aquatic environments

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[2]	Asset characteristics
Horseshoe Lagoon[1]	Goulburn	Goulburn Broken CMA	1 2	JAMBA, CAMBA, ROKAMBA Tall Marsh - Depleted – EVC 821 Floodway Pond Herbland – Vulnerable, EVC 810 Floodplain Riparian Woodland – Vulnerable, EVC 56 EPBC Act, FFG Act, DSE list
Kanyapella Basin[1]	Goulburn	Goulburn Broken CMA	TBC	TBC
Loch Garry[1]	Goulburn	Goulburn Broken CMA	1 2	JAMBA, CAMBA EPBC Act, FFG Act, DSE list Tall Marsh – Least Concern – EVC 821 Floodway Pond Herbland – Depleted – EVC 810 Riverine Swamp Forest – Depleted - EVC 814 Sedgy Riverine Forest - Depleted - EVC 816 Riverine Grassy Woodland – Vulnerable – EVC 295 Riverine Swampy Woodland - Vulnerable – EVC 815 Sand Ridge Woodland - Endangered – EVC 264
Reedy Swamp	Goulburn River	Goulburn Broken CMA	1 2 4 5	JAMBA, CAMBA, ROKAMBA, Bonn Convention Reedy Freshwater Marsh – only 30% remains since settlement Tall Marsh – Endangered, EVC821 EPBC Act, FFG Act, DSE list High biodiversity
Doctors Swamp	Goulburn River	Goulburn Broken CMA	1 2 4 5	JAMBA, CAMBA, ROKAMBA, Bonn Convention Shallow freshwater marsh Plains Grassy Wetland – Endangered, EVC125 Plains Woodland – Endangered, EVC803 EPBC Act, FFG Act, DSE list High biodiversity

Asset Name	Catchment	Asset Manager	Schedule 8 Criteria[2]	Asset characteristics
Moodies Swamp	Broken Creek	Goulburn Broken CMA	1 2 4 5	JAMBA, CAMBA, ROKAMBA, Bonn Convention Shallow freshwater marsh Cane Grass Wetland – Vulnerable EVC291 EPBC Act, FFG Act, DSE list High biodiversity
Ovens River Catchment				
Mullinmur Wetland[1]	Ovens	North East CMA	3 4 5	Only catfish population in NE Vic (endangered under FFG Act)
Ovens River, including King and Buffalo Rivers	Ovens	North East CMA	2 3 4 5	One of the last unregulated rivers in the MDB Entire lower Ovens system is of high environmental value due to its relative intactness and near natural flow regime Heritage listed High habitat diversity Complex instream woody habitat Cobbles, riffles, pools, bars Anabranches, flood runners Littoral fringe Provides connectivity to facilitate migration, movement and dispersal EPBC Act, FFG Act, DSE list High biodiversity

[1] These assets will be assessed for inclusion as priority environmental assets in the next LTWP update following the BWS update planned for 2023.

[2] Numbers in the asset characteristics refer to Schedule 8 Criteria.

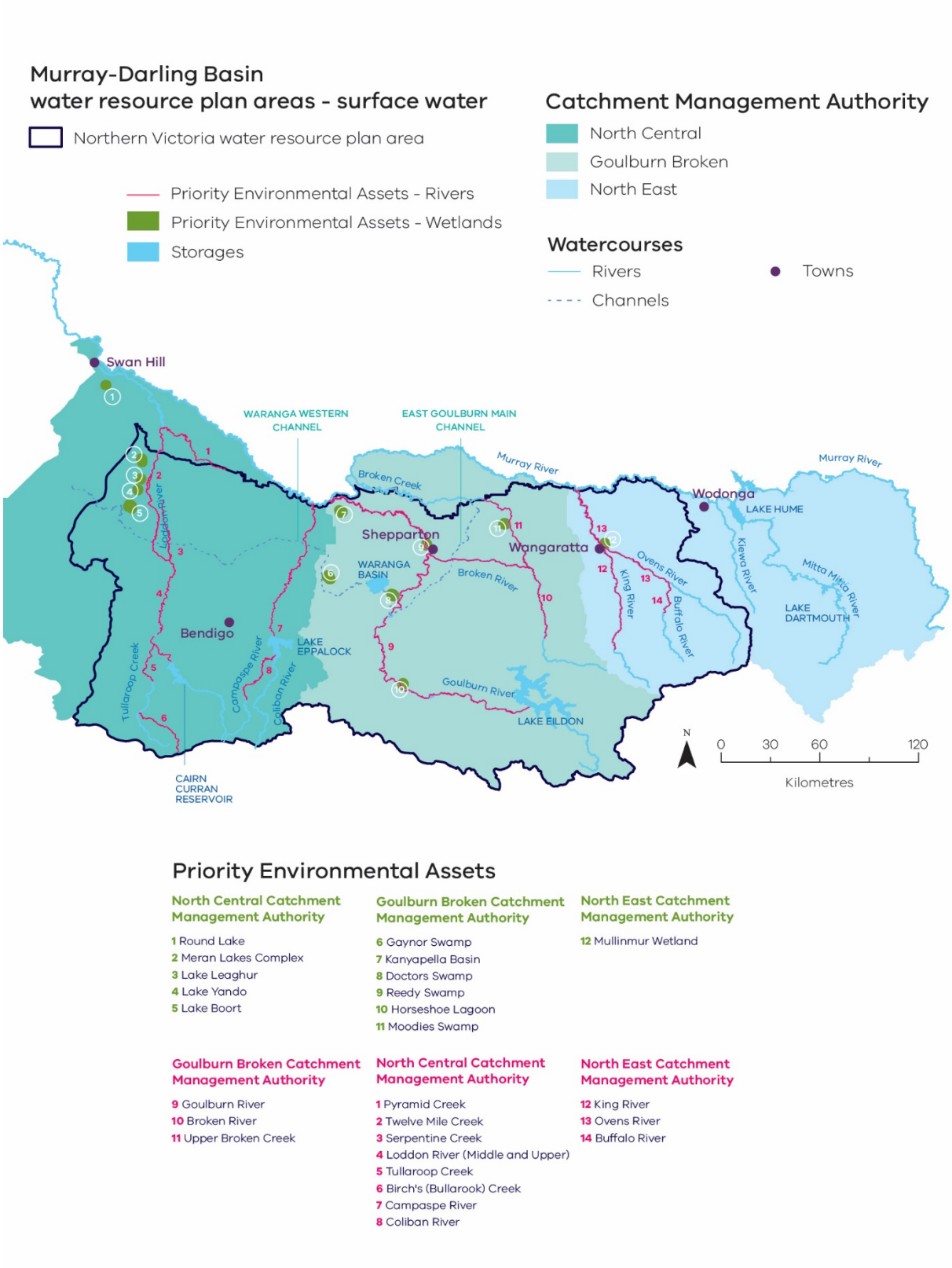


Figure 9: Priority environmental assets within the Northern Victoria water resource plan area

2.5 Priority ecosystem functions in the Northern Victoria water resource plan area

Three ecosystem functions are prioritised for the Northern Victoria water resource plan area longitudinal connectivity, water quality and geomorphic habitat (Table 6), derived from those identified at the asset scale through EWMP objective setting for environmental watering. This is not a comprehensive list of all possible functions that may exist, either at the asset or the water resource plan area scale. Future iterations of Victoria's LTWPs will better integrate the environmental values and outcomes at the asset scale with those at the landscape scale (single or multiple water resource plan area), providing a broader picture of priority ecosystem functions.

The priority ecosystem functions in Table 6 can be managed with environmental water and meet the criteria in Basin Plan schedule 9. The individual assets associated with these functions are listed in Table 9 of Section 3.

Table 6: Priority ecosystem functions in the Northern Victoria water resource plan area

Ecosystem Function	Schedule 9 criteria	Function characteristics
Longitudinal hydrological connectivity (between river reaches for fish movement)	2	Supports the transportation and dilution of nutrients, organic matter and sediment
	3	Provides connections along a watercourse (longitudinal connections)
Water quality (that allows for ecosystem processes)	1	Supports the creation and maintenance of vital habitats
	2	Supports the dilution of carbon and nutrients from the floodplain to the river system
Geomorphic habitat	1	Supports the creation and maintenance of vital habitats

3. Environmental watering requirements for priority environmental assets and ecosystem functions

This section outlines ecological objectives and targets, with watering requirements, for priority environmental assets and functions in the Northern Victoria water resource plan area.

3.1 Approach to developing objectives, targets and watering requirements

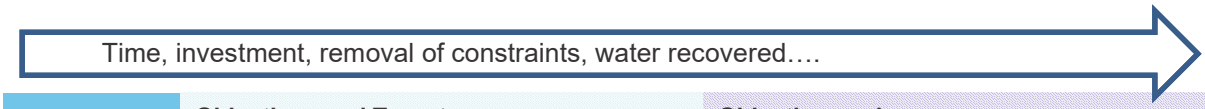
The objectives for this LTWP have been developed from the EWMPs, environmental flow studies and watering guides prepared by CMAs for priority environmental assets across the Northern Victoria water resource plan area. LTWP objectives and their targets show the overall alignment of EWMPs with Basin Plan objectives and how they will be met. They show the alignment with management goals developed for the Basin (see Section 1.1) and for the Northern Victoria water resource plan area (see Table 7). Objectives may be set in terms of ecological outcomes (e.g. specific biota or ecological functions) or the hydrological requirements (e.g. flow, depth, timing) of specific biota or functions. Only when objectives have been set can an appropriate watering regime be developed.

The approach to developing LTWP objectives, targets and watering requirements is described in Appendix C. The approach builds on the asset-scale information from EWMPs, which include site-specific ecological objectives (Appendix E) and watering requirements (Appendix F). These were categorised, analysed and regrouped to build a set of objectives suitable for the water resource plan area scale.

Targets developed for this LTWP are designed to be 'SMART': Specific, Measurable, Attainable, Relevant and Time-bound. Targets were only set for objectives which are sensitive to environmental water, had available indicators and were relevant to the water resource plan area. From there, targets were developed using a standard framework.

Watering requirements for the objectives and targets are provided in Section 3.5. At the regional scale, this is done by linking the objectives and targets to the relevant flow components. The EWMPs, and Seasonal Watering Plans (developed each year), provide further detail on the watering requirements at an asset scale (VEWH, 2020). More detail on watering requirements from the EWMPs is provided in Appendix F.

This LTWP has been developed with objectives and targets aimed at a 10-year planning horizon. While aspirational statements can provide some indication of the long-term outcome for assets and resources, they do not provide a good basis for target setting in the short-term. Longer-term aspirational outcomes have been balanced with the more certain shorter-term in setting the objectives and targets in this LTWP, as illustrated in Figure 10.



	Objectives and Targets		Objectives only	
Certainty of achievement	**1 – can meet now**	**2 – can meet under BP implementation timeframe**	**3 – can meet under BP implementation if constraints removed / decreased**	**4 – beyond scope of BP implementation**
timeline	1-5 years	5-10 years	TBC	TBC

Figure 10: Certainty of achievement has been used in setting objectives and targets in this LTWP. Longer-term aspirational objectives have not had targets set, due to uncertainty in future conditions and ability for associated targets to be met

3.2 Management goals for the Northern Victoria water resource plan area

The North Central, Goulburn Broken and North East CMAs developed site-specific environmental water management goals in consultation with communities through the EWMP process. During development of the Northern Victoria LTWP, these were summarised into management goals for the Northern Victoria WRP area (see Table 7). Management goals for individual assets are presented in Appendix E.

These goals also help to support a range of valuable co-benefits such as improved health of culturally significant species and sites.

Table 7: Management goals for the Northern Victoria water resource plan area

Management goals
Maintain or improve populations of threatened species and communities that are dependent upon waterways that receive environmental water in the region.
Maintain or improve the connectivity within and between the different types of waterways
Maintain the condition of waterways that are formally recognised and in a near-natural or ecologically healthy state.
Provide flow regimes that protect and improve the region's important aquatic flora and fauna, instream habitats, connected floodplains and ecological processes.
Build populations of threatened native fish and ensure that they are resilient
Provide watering regimes in wetlands that support the recruitment and maintenance of river red gum habitats, and promote the growth of a diverse range of aquatic and amphibious plant species offering a variety of habitats to waterbirds, reptiles and amphibians, and ensure opportunities for waterbird foraging, nesting and breeding.

3.3 Environmental objectives for the Northern Victoria water resource plan area

Twenty-seven environmental objectives have been developed for the Northern Victoria water resource plan area and are set out in Table 8 below. The objectives are grouped into themes that correspond to those used in the MDBA Ecological Assets and Functions Database. How these LTWP objectives contribute to Basin Plan objectives is shown in the cross-referencing to relevant objectives from the BWS's Expected Environmental Outcomes (EEOs), and Basin Plan environmental watering plan (EWP) (both listed in Appendix K, Table 35 and Table 36).

Table 8: Environmental objectives for the Northern Victoria water resource plan area

Theme	No.	Objectives	BWS EEOs	EWP Objectives
Connectivity and Functions	NV1	Improve longitudinal connectivity (between river reaches and with the Murray)	B1.1, B1.2, B1.3, B1.4, B1.5, B4.1, B4.6, B4.8, B4.9, B4.10	8.06,3(a), 8.06,3(b)(i) 8.06,3(b)(ii), 8.06,3(f) 8.06,6(b), 8.07,6
	NV2	Maintain water quality within an appropriate range to allow for ecosystem processes	B4.1-10	8.06,2, 8.07,5
	NV3	Maintain the quality of geomorphic habitat (maintain channel form, clean substrates, prevent stream bed colonisation)	B1.1	8.06,4
Vegetation	NV4	Maintain the condition of aquatic vegetation in wetlands	B2.13	8.05,3(b), 8.06,3(a) 8.06,5, 8.06,7
	NV5	Maintain the condition of in-channel aquatic vegetation	B2.12	8.05,3(b), 8.06,3(a) 8.06,5, 8.06,7
	NV6	Improve the extent of aquatic vegetation	B2.11, B2.12, B2.13	8.05,3(b), 8.06,2 8.06,3(a), 8.06,5 8.06,6(a), 8.06,7
	NV7	Improve the abundance of aquatic vegetation	B2.11, B2.12, B2.13	8.05,3(b), 8.06,2 8.06,3(a), 8.06,5 8.06,6(a), 8.06,7
	NV8	Improve the species richness of aquatic vegetation in wetlands	B2.13	8.05,3(b), 8.06,3(a) 8.06,5, 8.06,7
	NV9	Improve the species richness of in-channel aquatic vegetation	B2.12	8.05,3(b), 8.06,3(a) 8.06,5, 8.06,7
	NV10	Maintain the extent of river red gum dominated EVCs	B2.1, B2.2, B2.8, B2.9	8.05,3(b), 8.06,3(b)(ii) 8.06,5, 8.06,6(a) 8.06,6(b), 8.06,7
	NV11	Maintain the condition of river red gum dominated EVCs	B2.1, B2.2, B2.8, B2.9	8.05,3(b), 8.06,3(b)(ii) 8.06,5, 8.06,6(a) 8.06,6(b), 8.06,7
	NV12	Improve species richness of river red gum dominated EVCs	B2.1, B2.2, B2.8, B2.9	8.05,3(b), 8.06,3(b)(ii) 8.06,5, 8.06,6(a) 8.06,6(b), 8.06,7
	NV13	Maintain the extent of black box dominated EVCs	B2.1, B2.2, B2.7, B2.8, B2.9	8.06,3(b)(ii), 8.06,6(a) 8.06,6(b)
	NV14	Reduce the extent of exotic vegetation		8.07,5
Waterbirds	NV15	Improve breeding opportunities for waterbirds	B3.1, B3.2, B3.4	8.06,6(a)
	NV16	Improve habitat for waterbirds	B3.1, B3.2, B3.3, B3.4	8.06,6(b)
Fish	NV17	Improve abundance of large-bodied native fish	B4.1, B4.2, B4.6, B4.8	8.06,6(a), 8.06,6(b) 8.07,3
	NV18	Improve abundance of small-bodied native fish in rivers	B4.1, B4.6, B4.10	8.06,5 8.06,6(a)

Theme	No.	Objectives	BWS EEOs	EWP Objectives
	NV19	Improve habitat for native fish	B4.1, B4.2, B4.6, B4.8	8.06,6(a) 8.06,6(b) 8.07,3
	NV20	Improve movement of native fish	B4.1-10	8.06,6(b)
	NV21	Maintain species richness of native fish	B4.1-10	8.06,6(a)
Other Fauna	NV22	Improve breeding of Platypus and Rakali	N/A	8.06,6(b) 8.07,3
	NV23	Maintain abundance of Platypus and Rakali	N/A	8.06,6(b) 8.07,3
	NV24	Improve breeding of frog communities	N/A	8.06,6(b) 8.07,3
	NV25	Maintain species richness of frog communities	N/A	8.06,6(b) 8.07,3
Invertebrates	NV26	Improve abundance of macroinvertebrates	N/A	8.06,6(b) 8.07,3
	NV27	Improve number of macroinvertebrate functional groups present	N/A	8.06,6(b) 8.07,3

Note: EWP Objective codes are the Basin Plan Chapter 8 Environmental Watering Plan objectives (Appendix K Table). BWS EEO codes are the Basin-wide environmental watering strategy Expected Environmental Outcomes (Table 36). Themes are from the MDBA Ecological Assets and Functions Database (MDBA, 2021).

These objectives relate to specific assets across the water resource plan area, as set out in Table 9. The location of the assets is shown in Figure 9 (Section 2.4) and the objectives for each asset can be found in Appendix E.

Table 9: Objectives and assets for the Northern Victoria water resource plan area

Theme	Objective	Assets
Connectivity and functions	Improve longitudinal connectivity (between river reaches and with the Murray)	Campaspe River; Ovens River; Loddon River;
	Maintain water quality within an appropriate range to allow for ecosystem processes	Birch's Creek; Campaspe River; Coliban River; Loddon River (mid, upper); Ovens River; Broken River
	Maintain the quality of geomorphic habitat (maintain channel form, clean substrates, prevent stream bed colonisation)	Coliban River; Loddon River (mid, upper); Goulburn River; Ovens River; Broken River
Vegetation	Maintain the condition of aquatic vegetation in wetlands	Lake Boort; Moodie Swamp; Lake Leaghur; Lake Yando; Lake Meran;
	Maintain the condition of in-channel aquatic vegetation	Broken River; Coliban River
	Improve the extent of aquatic vegetation	Lake Leaghur; Lake Yando; Lake Meran Campaspe River; Loddon River (mid, upper); Goulburn River; Broken River
	Improve the abundance of aquatic vegetation	Moodie Swamp; Lake Meran Birch's Creek; Coliban River; Goulburn River
	Improve the species richness of aquatic vegetation in wetlands	Lake Boort; Lake Leaghur; Lake Yando; Lake Meran;

Theme	Objective	Assets
	Improve the species richness of in-channel aquatic vegetation	Birch's Creek; Coliban River; Goulburn River
	Maintain the extent of river red gum dominated EVCs	Lake Boort; Coliban River; Loddon River (mid, upper)
	Maintain the condition of river red gum dominated EVCs	Campaspe River; Loddon River (upper); Lake Leaghur; Lake Yando
	Improve species richness of river red gum dominated EVCs	Doctors Swamp
	Maintain the extent of black box dominated EVCs	Lake Boort; Loddon River (mid)
	Reduce the extent of exotic vegetation	Reedy Swamp; Doctors Swamp; Moodie Swamp; Birch's Creek
Waterbirds	Improve breeding opportunities for waterbirds	Doctors Swamp; Moodie Swamp; Lake Leaghur; Lake Yando
	Improve habitat for waterbirds	Reedy Swamp; Lake Meran; Lake Yando
Fish	Improve abundance of large-bodied native fish	Birch's Creek; Campaspe River; Loddon River (mid, upper); Goulburn River; Broken River; Ovens River
	Improve abundance of small-bodied native fish in rivers	Birch's Creek; Coliban River; Loddon River (mid, upper); Broken River; Ovens River; Goulburn River
	Improve habitat for native fish	Birch's Creek; Coliban River; Loddon River (upper); Goulburn River; Ovens River
	Improve movement of native fish	Campaspe River; Loddon River (mid, upper); Goulburn River; Broken River; Ovens River
	Maintain species richness of native fish	Birch's Creek; Coliban River
Other values	Improve breeding of Platypus and Rakali	Birch's Creek; Campaspe River; Coliban River
	Maintain abundance of Platypus and Rakali	Loddon River (mid, upper)
	Improve breeding of frog communities	Doctors Swamp; Lake Yando
	Maintain species richness of frog communities	Reedy Swamp
Macroinvertebrates	Improve abundance of macroinvertebrates	Goulburn River; Birch's Creek; Coliban River; Loddon River (mid, upper)
	Improve number of macroinvertebrate functional groups present	Birch's Creek; Campaspe River; Coliban River Loddon River (mid, upper)

3.4 Ecological targets for environmental watering in the Northern Victoria water resource plan area

Targets have been developed for a subset of the objectives developed for this water resource plan area (Table 10). The process for the development of the targets is set out in Appendix C (original set of targets) and Appendix D (revised targets based on the LTWP monitoring and evaluation plan).The aim was to make them more measurable, unambiguous, time-bound and set clear thresholds for success.

The targets have been developed to measure progress towards the objectives. They are designed to enable reporting at a Basin level and as a consequence, while targets have been developed for only a selection of

objectives, it is expected that water will be provided to meet all objectives set out in this LTWP. Like the development of ecological objectives, the targets have been developed based on a set of common terms and definitions. For this LTWP:

- 'Maintain' means to prevent further decline (this does not discount an improvement as an acceptable outcome).
- 'Improve' is a general term based on the objectives in the EWMPs. The term refers to an increase in the nominated attributes of the target.
- 'Habitat' refers to water-based/instream/riparian habitat.
- Waterbird guilds are based on feeding and habitat requirements. The main guilds northern Victoria are piscivores (e.g. pelicans and cormorants), water fowl (e.g. ducks and coots), rallids (e.g. Rails and crakes) and waders and shorebirds (e.g. spoonbills and ibis).
- EVC benchmarks have a list of "typical" species and lifeforms (e.g. shrub, herb) found in each EVC in a particular bioregion. EVCs with trees (usually terrestrial and riparian EVCs) have standards for tree size and density, organic litter, recruitment and presence of large logs. The condition score for an EVC benchmark is the sum of the ratings for each component of the benchmark (large trees, tree canopy cover, understorey composition, weeds, recruitment, organic litter and large logs), as outlined in the Vegetation Quality Assessment Manual (DSE, 2004) for terrestrial vegetation. For wetland vegetation, the biota sub-index is used, as outlined in the Index of Wetland Condition assessment procedure (DEPI, 2013a).

Refinement of targets is an ongoing process, and this will be reflected in future iterations of this LTWP. Monitoring of the Northern Victoria LTWP is discussed in Section 8.

Table 10: Targets for the Northern Victoria water resource plan area

Theme	Objective	Previous Target	Revised Target	Recommended Assets
Fish	Improve abundance of large-bodied native fish.	A positive trend in the catch per unit effort (CPUE) of large bodied native fish over the ten-year period to 2025.	A) The mean number of sites where large-bodied native fish species are detected is the same or higher in the last five years than the first five years of a ten year monitoring program B) For age classes up to five years, the number of cohorts is the same or higher in the last year than the first year of a ten year monitoring program	Birch's Creek; Campaspe River; Loddon River (mid, upper); Goulburn River; Broken River; Ovens River
	Maintain species richness of native fish	Maintain the number of native fish species recorded in Sustainable Rivers Audit (SRA) list, in 80% of years to 2025	The ratio of fish species observed to expected (using pre-European Reference Condition - PERCH) is the same in the first three years as the last three years of a ten year monitoring period	Birch's Creek; Coliban River
Waterbirds	Improve habitat for waterbirds	Appropriate water regime to support feeding and habitat areas for different guilds of waterbirds delivered at 50% of sites, 8 years in 10.		Reedy Swamp; Doctors Swamp; Moodie Swamp; Lake Leaghur; Lake Meran; Lake Yando

Theme	Objective	Previous Target	Revised Target	Recommended Assets
Vegetation	Maintain the condition of aquatic vegetation in wetlands	The 2009-2011 IWC [2] biota score maintained at 90% of priority wetland assets in 2025.	The condition of wetland vegetation in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets: • cover/abundance of native species • native species richness • recruitment of woody and non-woody understorey and survival of juvenile plants	Lake Boort; Moodie Swamp; Lake Leaghur; Lake Yando; Lake Meran;
	Maintain the condition of river red gum dominated EVCs	Condition of river red gums dominated EVC[3] to be maintained at 80% of sites in 2025.	The condition of river red gum dominated EVCs in the asset improves over ten years as measured by the following sub-targets: • health of adult river red gum trees • recruitment and survival of juvenile trees • native species richness • native species cover/abundance • recruitment of understorey vegetation	Campaspe River; Loddon River (mid, upper); Lake Leaghur; Lake Yando;
Connectivity	Improve longitudinal connectivity (between river reaches and with the Murray)	Meet baseflow and fresh flow requirements in 90% of years, in order to connect and contribute flows to the River Murray.		Campaspe River; Ovens River; Loddon River; Goulburn River
Other values	Maintain species richness of frog communities	Maintain the number of native frog species recorded in 80% of years to 2025.	The number of frog species observed in eight in a ten years period must be more than 75% of the highest diversity recorded in any one year.	Reedy Swamp

[1] Sustainable Rivers Audit
[2] Index of Wetland Condition
[3] Ecological Vegetation Class

3.5 Watering requirements of the objectives

This section describes the key components of the flow regime needed to meet objectives. Asset specific watering requirements are documented in EWMPs, seasonal watering proposals, and the VEWH's seasonal watering plan. Each of these uses the seasonally adaptive approach (DSE, 2009), where priorities for environmental watering, works and complementary measures in any given year vary according to climatic conditions and water availability.

3.5.1 Watering requirements of river assets

Watering requirements for rivers are specified in terms of flow components – low flow, freshes, high flow and overbank flow (Figure 11). In regulated rivers, many of the flow components that are needed can be provided through held environmental water (see Section 4.2) provided sufficient water is available. It is relatively straightforward to deliver baseflows and to return some of the small and medium-sized freshes that are critical in the life cycles of various native plants and animals. Baseflows provide the basic habitat for in-stream biota, while freshes can trigger fish migration and spawning, move sediment and nutrients through river systems, connect habitats and improve water quality. However, very high flows (including bankfull and overbank flows) are generally not feasible (due either to the volume of water required, infrastructure constraints or potential flooding issues), although natural flows can be "topped up" to meet critical depth or duration requirements. Figure 11 graphically depicts the benefits of different environmental flow components in rivers.

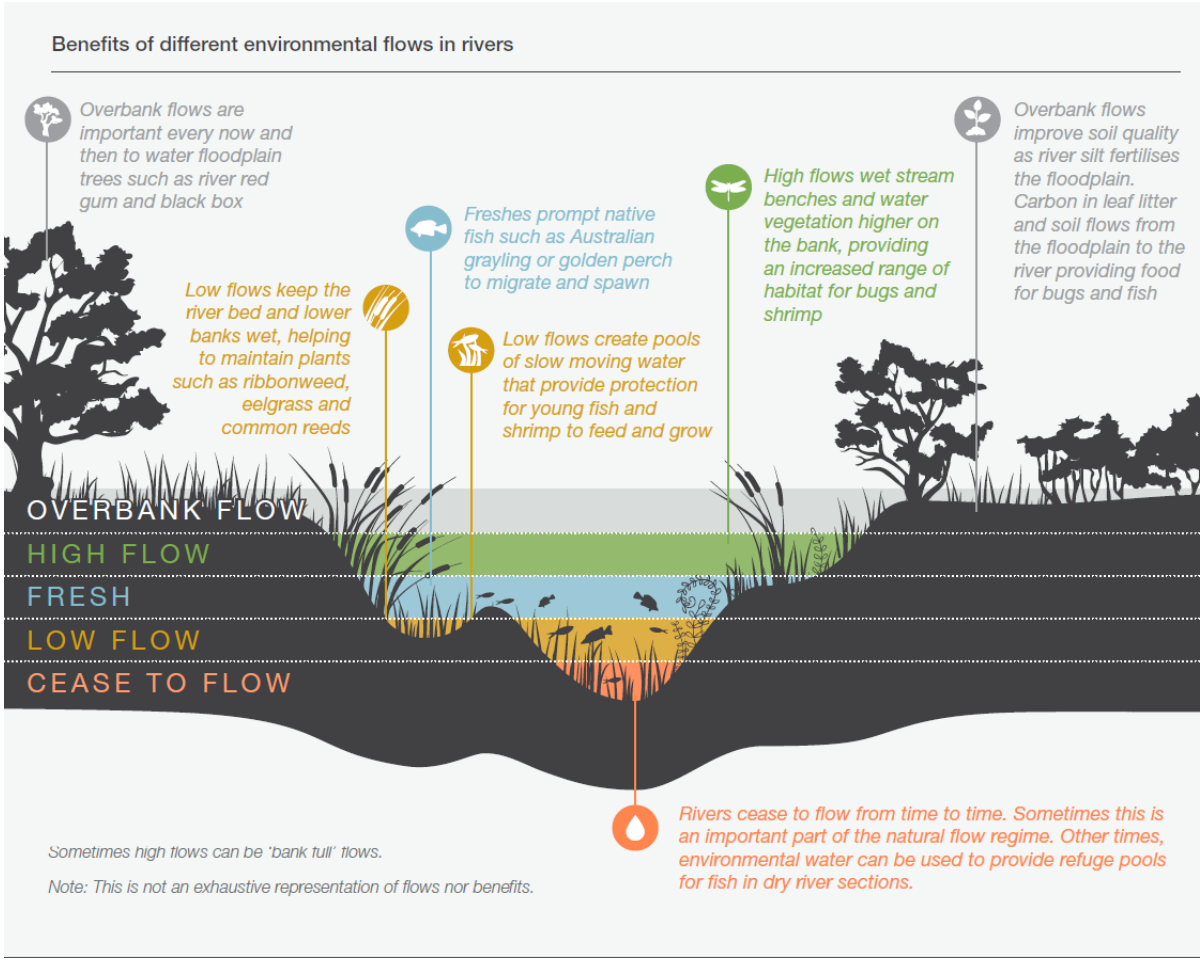


Figure 11: Benefits of different environmental flow components in rivers (VEWH, 2015)

Table 11 and Table 12 show the flow components required to describe the water requirements to achieve the environmental objectives for river assets. While the flow components apply across all rivers assets, the details (flow rate, timing, frequency and duration) will be asset specific. An example of flow components required to meet environmental objectives, for the Kaiela (Lower Goulburn River) is presented in Table 13 (Horne, et al., 2020).

In addition to watering recommendations in flow studies for rivers assets and EWMPs for wetlands, the environmental watering requirements of priority ecosystem assets has been captured in Environmental Assets and Functions Database (EAFD) (MDBA, 2021). This database contains the objectives, targets and associated watering regime for all priority environmental assets receiving environmental water across the Murray-Darling Basin. It is a valuable resource all environmental water delivery partners (i.e. CEWH, VEWH, state agencies and water corporations) and can be used to interrogate watering requirements at varying scales, from single environmental assets up to CMA and water resource plan scales. An example of the information contained in the database is presented in Table 14.

Table 11: Flow components required to meet native fish and vegetation objectives related to river-based assets

	Native fish objectives				Vegetation objectives				
Flow component	Improve abundance of large-bodied native fish	Improve abundance of small-bodied native fish	Improve movement of native fish	Maintain species richness of native fish	Improve condition of riparian EVCs	Improve abundance of aquatic vegetation	Maintain extent of aquatic vegetation	Maintain the species richness of in-channel aquatic vegetation	Maintain the condition of black box dominated EVC communities
Low flow	✓	✓	✓	✓		✓	✓	✓	
Freshes	✓	✓	✓	✓		✓	✓	✓	
High Flow				✓	✓				
Overbank flow					✓				✓
Explanation (based on conceptual models)	Low flows all year for habitat; July to November fresh for breeding trigger	Low flows all year for habitat; summer fresh for habitat quality	Winter low flow for widespread movement; summer fresh for local movement; July to November fresh for movement trigger	Low flows for habitat; freshes and high flows for channel maintenance, habitat quality, movement and breeding	Overbank flows for watering managed floodplain	Low flows for habitat; summer fresh for dispersal of propagules into disturbed habitats	Low flows for habitat; summer fresh for dispersal of propagules into disturbed habitats	Low flows for habitat; summer fresh for dispersal of propagules	Overbank flows for watering managed floodplain

Note: volume, timing, duration and frequency for each of these elements is asset specific.

Table 12: Flow components required to meet functions and 'other' objectives related to river-based assets

	Functions			Other objectives		
Flow component	Improve connectivity between river reaches to facilitate movement of native fish	Maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation	Maintain refuges for native fish species	Maintain the quality of geomorphic habitat	Improve habitat for Platypus	Maintain habitat for crayfish communities
Low flow	✓	✓	✓	✓	✓	✓
Freshes	✓	✓	✓	✓		
High Flow				✓		
Overbank flow						
Explanation (based on conceptual models)	Summer freshes and winter low flows provide adequate depth for fish movement	Low flows to prevent water quality decline; freshes to flush pools	Low flows to keep watered habitat present; freshes to prevent water quality decline	Winter low flow to prevent stream bed colonisation; freshes to maintain channel form and clean substrates	Low flow for habitat	Low flow for habitat

Note: volume, timing, duration and frequency for each of these elements is asset specific.

Table 13 Summary of environmental flow recommendations for the Kaiela (Lower Goulburn River) (Horne, et al., 2020)

PRIORITY	FLOW COMPONENT	MAGNITUDE	DURATION	TIMING	FREQUENCY	RELEVANT OBJECTIVES
1	**Year round Baseflow** (Providing habit diversity and sustaining the system)	• Preferred flows are between 500 – 1000 ML/d (or natural) during summer and autumn • During summer and autumn, ensure variability in flow regime (CV > 0.2) (e.g. mean of 750 and standard deviation of 150 ML/d) • During winter and spring ensure flow is greater than 500 ML/d	• N/A	• Year round	• Every Year	All Fish, Instream Productivity, Macroinvertebrates, Littoral Vegetation, Midbank Vegetation, Bank Stability, Turtles, Social
2a	**Overbank or high flows** (channel forming event)	• Opportunistic event – aim to provide as high as possible an event by piggybacking natural event. Where overbank not possible, still provide as large an event as possible (aiming for 15,000 ML/d) for channel maintenance and forming • >30,000 ML/d allow significant area of floodplain vegetation to be inundated • >20,000 ML/d inundates floodplain near Loch Garry • >10,500 ML/d starts to inundate low lying flood runners and anabranches	• Areas on the lower • floodplain will fill instantaneously. • 5 days at peak to fill larger wetlands (base this on opportunity to piggyback)	• Ideally late winter to spring or as naturally • induced • Not during summer to minimize black water events.	• As often as possible given natural flow events • Aim for an event >10,500 each year (rainfall runoff or release) • >20,000 7 in 10 years or as per natural rainfall runoff • >30,000 Natural frequency	Opportunistic Fish, Periodic/Equilibrium Fish, Instream Productivity, Macroinvertebrates, Littoral/Bank Vegetation, Floodplain Vegetation, Instream Habitat Complexity, Turtles, Platypus
2b	**Early Spring fresh** (Priming the system)	• (Provide if 2a not achievable or if 2a occurred early in winter allowing a second fresh) • Range 5,000 ML/d to 10,500 ML/d • >5000 ML/d provide some benefit for bank vegetation • >7300 ML/d to mobilize bed sediments and scour fine sediment	• 7 days at peak	• At least one annually in early spring	• Yearly	All Fish, Macroinvertebrates, Littoral/Bank Vegetation, Instream Habitat Complexity
4	**Autumn fresh** (flow variability and ecosystem maintenance)	• >5700 ML/d to reset surfaces	• 1 – 2 day at peak for vegetation and scouring • 7 days at peak for migration of fish	• During the growing season	• Yearly	All Fish, Macroinvertebrates, Littoral/Bank Vegetation, Instream Habitat Complexity
5	**Late Spring fresh** (to cue fish spawning)	• >7,500 ML/d for high chance of spawning • >5600 ML/d for any benefit	• 2 day at peak	• Nov – Dec when Water temperature > 19°C	• Yearly	Periodic Fish, Macroinvertebrates, Instream Habitat Complexity
6	**Winter-Spring variable baseflow** (Ensure habitat diversity)	• Variability required – mimic natural variability by passing freshes and larger events from tributaries • >500 ML/d - natural	• N.A	• Winter/spring	• Yearly	All Fish, Macroinvertebrates, Littoral Vegetation, Midbank Vegetation, Instream Habitat Complexity

Table 14: Example output from the MDBA Environmental assets and functions database (MDBA, 2021)

PlanningUnitName	StartWatPer	EndWatPer_	Condition	FlowMagnit	FlowUnit_D	WateringDuration_Original
Birch's Creek Reach 1	December	May	Any	3	ML/d	6 months Dec-May
Birch's Creek Reach 1	December	March	WET	10	ML/d	3 days
Birch's Creek Reach 1	April	November	DRY	5	ML/d	6 months Apr-Nov
Birch's Creek Reach 1	April	November	WET	10	ML/d	6 months Apr-Nov
Birch's Creek Reach 1	June	November	WET	30	ML/d	5 days in wet/average years
Birch's Creek Reach 1	June	November	DRY	30	ML/d	3 days in dry years
Birch's Creek Reach 1	June	November	WET	160	ML/d	3 days
Birch's Creek Reach 1	April	November	AVERAGE	10	ML/d	6 months Apr-Nov
Birch's Creek Reach 1	December	March	AVERAGE	10	ML/d	3 days
Birch's Creek Reach 1	June	November	AVERAGE	30	ML/d	5 days in wet/average years
Birch's Creek Reach 1	December	March	DRY	10	ML/d	3 days
Birch's Creek Reach 1	June	November	AVERAGE	160	ML/d	3 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	December	May	Any	>30	ML/d	
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	September	May	Any	>30-100	ML/d	
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	Any	200	ML/d	
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	December	May	Any	>30-100	ML/d	
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	Any	>30-100	ML/d	
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	Any			
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	WET	270	ML/d	9 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	AVERAGE	270	ML/d	6 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	DRY	270	ML/d	3 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	WET	400	ML/d	8 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	AVERAGE	400	ML/d	5 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	DRY	400	ML/d	2 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	WET	500	ML/d	8 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	AVERAGE	500	ML/d	5 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	DRY	500	ML/d	2 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	WET	4400	ML/d	2 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	AVERAGE	4400	ML/d	1 day
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	WET	>175	ML/d	5 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	AVERAGE	>175	ML/d	5 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	DRY	>175	ML/d	3 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	AVERAGE	4400	ML/d	1 day
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	July	June	WET	4400	ML/d	2 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	WET	4000	ML/d	2 days
Broken River Reach 1: Lake Nillahcootie to Holland's Creek	June	November	AVERAGE	4000	ML/d	1 day

3.5.2 Watering requirements for wetland assets

The Northern Victoria water resource plan area contains a considerable diversity of wetland types (see Section 2.3), although based on area the priority ecosystem assets are predominantly temporary river red gum swamp, freshwater meadow, permanent lakes and permanent wetlands. Historically, wetland assets would typically receive water from high river flows in wet winter/spring periods, although very heavy rainfall in summer/autumn can lead to substantial inflows into wetlands. Land and water resource development since European settlement has altered the frequency, timing and duration of rivers flows , putting at risk the ecological values of priority wetland assets. Environmental water can be used to reinstate a more natural watering regime, including a wetting and drying cycle where appropriate.

In wetlands, phases of the watering regime include (Figure 12):

- Drying – declining water levels due to outflows, seepage and evaporation.
- Dry – no water in wetland.
- Filling – inflow of water and increasing water levels; can be a trigger for watering events
- Full – the wetland is filled to the natural outflow or “sill” level and only evaporation and recharge to groundwater will subsequently reduce volume. May be topped up to increase the duration of inundation.
- Flooded – water level is higher than the natural sill; occurs during floods or watering events that target the surrounding areas (e.g. fringing vegetation).

Table 15 and Table 16 describe phases of the wetting and drying cycle that contribute to ecological objectives for **wetland** assets. The environmental watering regime for each priority ecosystem asset is described in EWMPs. An example of the wetland watering requirements is presented in Table 17, which shows the requirements for Lake Meran.

While the water regime components apply across all wetland assets, the details (timing, duration and frequency) will be site specific and will vary year to year depending on antecedent conditions and the availability of environmental water. These factors are considered annually as part of development of the VEWH’s Seasonal Watering Plan. Another consideration when deciding which wetlands receive environmental water in any year is maintaining a mosaic of wetland habitat types across the region. This will increase habitat availability over time for waterbirds and allow other water dependent plants and animals to disperse across the landscape (Morris, 2012).

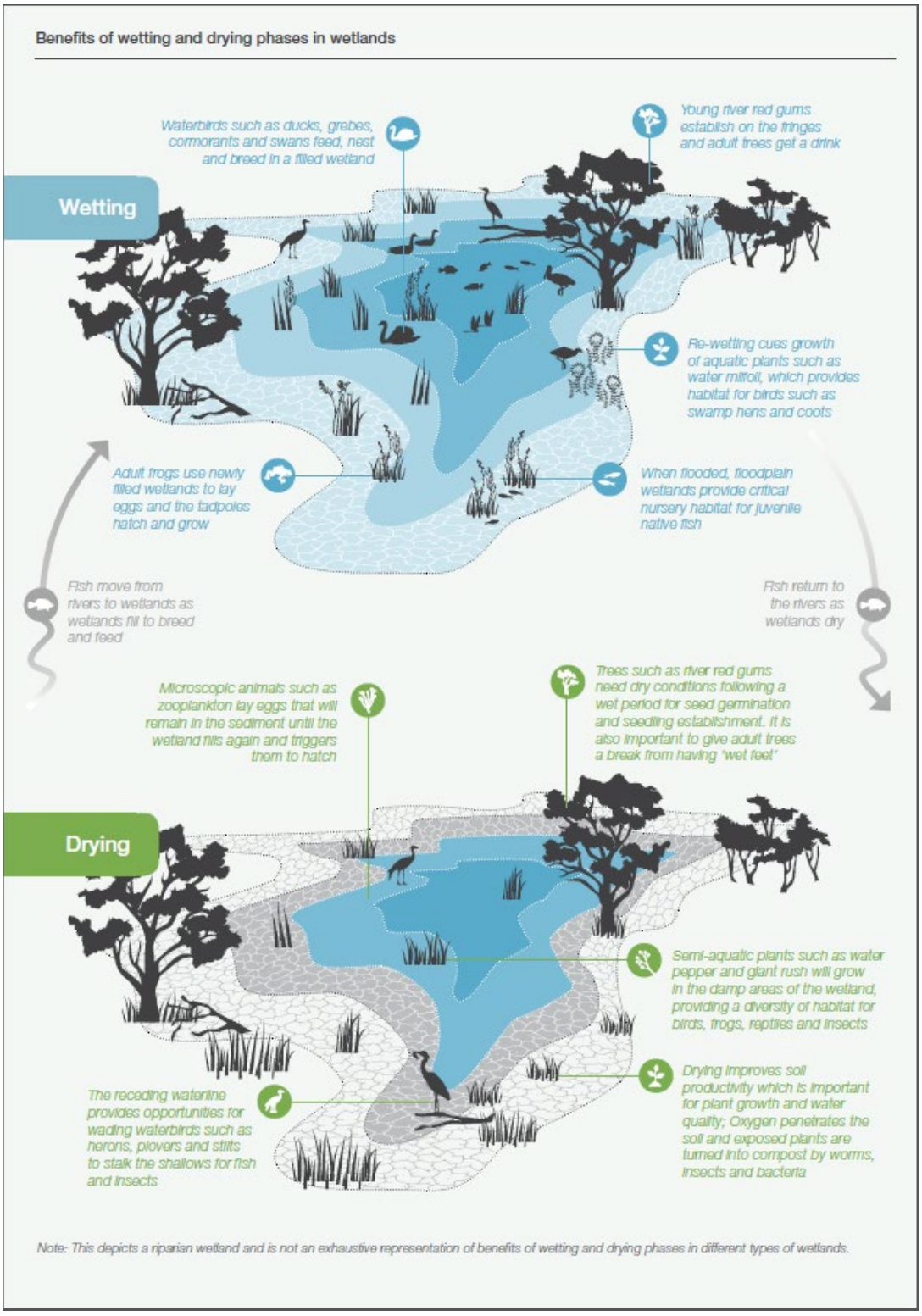


Figure 12: Benefits of wetting and drying phases in wetlands (VEWH, 2015)

Table 15: Elements of the wetting/drying cycle required to meet waterbird and vegetation objectives for wetland-based assets

	Waterbird objectives		Vegetation objectives						
Cycle component	Improve breeding opportunities for waterbirds	Improve habitat for waterbirds	Maintain the extent of aquatic vegetation	Improve the abundance of aquatic vegetation	Maintain the species richness of aquatic vegetation in wetlands	Improve condition of Wetland EVCs	Maintain extent of Wetland EVCs	Maintain the condition of black box dominated EVC communities	Reduce extent of exotic vegetation
Regional mosaic		✓				✓			
Dry					✓	✓			✓
Filling	✓			✓		✓			✓
Full	✓	✓	✓	✓	✓	✓		✓	✓
Flooded						✓	✓	✓	
Drying		✓		✓	✓	✓		✓	✓
	Timing of filling important; full level determines duration	Mosaic provides different habitats across region; full level determines area of habitats and duration; drying wetlands provide additional habitat types	Full level represents the maximum extent of wetted area	Filling and natural drying promotes germination and diversity of habitats	Filling and natural drying promotes germination of different functional groups and diversity of habitats	Different EVCs will have different watering requirements at a local level	Managed floodplain level represents the maximum extent of communities	Flooding to manage wetland extent then reducing to full level will water adult trees, but prevent waterlogging	Drying a wetland may reduce aquatic weeds, filling may reduce terrestrial weeds

Note: volume, timing, duration and frequency for each of these elements is asset specific.

Table 16: Elements of the wetting/drying cycle required to meet frog, turtle and crayfish objectives for wetland-based assets

	Other objectives		
	Maintain habitat for frog communities	Maintain habitat for turtle communities	Maintain habitat for crayfish communities
Cycle component			
Regional mosaic	✓	✓	
Dry			
Filling	✓		
Full	✓	✓	✓
Flooded			
Drying			
Explanation (based on conceptual models)	Mosaic provides different habitats across region; frog breeding triggered by filling; full level to allow time for metamorphosis	Mosaic provides different habitats across region; full level provides maximum available habitat	Full level provides maximum available habitat

Note: volume, timing, duration and frequency for each of these elements is asset specific.

Table 17: Example portion of the environmental water requirements for Lake Meran (NCCMA, 2016)

Ecological objectives		Water management area	Hydrological Requirements											
			Recommended number of events in 10 years			Inter-drying period duration (months)			Duration of ponding (months)			Preferred timing of inflows	Approx. target volume (ML) and depth (m AHD)	Depth (m)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max			
1.	**Fauna objectives**													
1.1	Maintain refuge and successful recruitment and survival of freshwater turtles, in particular Murray River turtles	Fringe	Murray River turtles prefer permanent well vegetated wetlands and prefer not to travel overland to other waterways.									NA	77.3 mAHD to 77.8 mAHD 1244 ML – 1750 ML	>1.5 m
1.2	Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds, including white-bellied sea-eagles, cormorants and Australian darter, black swans and grebes	Fringe and bed	2	3	10	Not known	24	48	7	10	-	Spring-Autumn	77.3 mAHD to 81.4 mAHD 1244 ML – 6720 ML	<3.5m
2.	**Vegetation objectives**													
2.1 a	Rehabilitate and increase the extent of Aquatic Herbland EVC 653 vegetation toward benchmark condition (e.g. *Myriophyllum* spp., *Vallisneria* spp. *Triglochin* spp., *Potamogeton* spp.)	Bed verges	2	7	9	12	36	60	4	8	11	Autumn-Spring	77.3 mAHD to 81.4 mAHD 1244 ML – 6720 ML	>10cm

4. Provision of environmental water

In Victoria, all water that is available for the preservation of the environmental values and health of water ecosystems is defined and protected as the Environmental Water Reserve (EWR) under the *Water Act* 1989 (Vic).

This section describes the provision of the EWR in Victoria's regulated and unregulated water systems.

Across all water resource plan areas, there are three key ways that Victorian water management meets environmental objectives:

1. Environmental water entitlements (bulk entitlements and environmental entitlements) and water shares that are held or managed by the Victorian Environmental Water Holder or Commonwealth Environmental Water Holder (CEWH) (see Section 4.2.1).
2. Passing flow requirements specified for environmental purposes under bulk entitlements or water supply protection area water management plans (see Section 4.2.2).
3. Other water managed through water system management rules, including passing flows not specified as having an environmental purpose, and unregulated river diversion rules. This includes water which remains in the system after consumptive and environmental entitlements are taken out - referred to as 'above cap' water – and water used primarily for consumptive purposes, but which can also have a benefit for the environment.

4.1 Water management in regulated and unregulated systems

The approach to meeting environmental objectives in Victoria's surface water systems depends on whether the water resources are unregulated or regulated.

In northern Victoria, the unregulated systems are generally tributaries of the larger regulated rivers, or upper reaches of regulated rivers upstream of reservoirs. Many unregulated rivers and streams in the Northern Victoria water resource plan area have high environmental value. As there are no major storages on these rivers and streams, flows in these unregulated systems are largely unmodified. While this is positive, the absence of large storages means that there is no held environmental water in these systems that can be released to target specific flow components. Environmental objectives in unregulated systems therefore are to protect the existing conditions (habitat), rather than provide a specific flow to meet an environmental objective for example, trigger fish spawning or water a particular vegetation community. No priority environmental assets or priority ecosystem functions have been identified in unregulated systems.

In unregulated systems, the impact on the environment is managed by specifying limitations on the timing and the rate of take in bulk entitlements and take and use licences. The volume of water which can be extracted by consumptive users can be further limited by restricting or banning take for take and use licence holders during times of low flow. Note that the domestic and stock take is still permitted even during bans which apply to use for irrigation and industry.

Regulated systems contain structures such as dams or major diversion weirs which exert significant control over the flow of water in the river for consumptive users. The impact of regulation on the environment will depend upon the size and number of storages and weirs, the level of consumptive use, and the overall volume of flow the river receives. For example, the Ovens system has two relatively small reservoirs, and receives relatively high annual river flows and is sometimes called semi-regulated, while the Goulburn River has two large storages and high consumptive demand, so the impact on the environment from regulation is much less in the Ovens River than in the Goulburn River.

Regulation of river systems has a significant impact on the environmental values of the system. Storages capture water during naturally high flow periods and retain it, to be released to meet consumptive demands

during drier times of the year, creating unnaturally high flows during summer. Storages create barriers to flow connectivity and biota migration. Environmental water can reduce the impact of river regulation and water extraction by providing flows at the right time of year for priority environmental assets and priority ecosystem functions (see Appendix E).

In regulated systems, environmental water requirements can be met with held environmental water and through planned environmental water (see Section 4.2.2) and other water (see Section 4.2.3). Other water in the system also supports environmental water outcomes. This includes passing flows requirements that meet multiple objectives, and delivery of water from reservoirs to downstream users, delivery of water from inter-valley trade accounts, or transfers from storages.

4.2 Held and planned environmental water

The *Water Act 2007* (Cth) identifies two types of environmental water: held and planned
Held environmental water is defined under section 4 of the *Water Act 2007* (Cth) to mean water available under a water access right, water delivery right or irrigation right for the purposes of achieving environmental outcomes, including water that is specified in a water access right to be for environmental use.
Planned environmental water is defined in section 6 of the *Water Act 2007* (Cth) and has three components:

- Water committed or preserved by an instrument.
- Water committed or preserved for the purpose of achieving an environmental outcome or other environmental purposes as specified in an instrument.
- Water that cannot, to the extent it is committed or preserved, be taken for any other purpose.

4.2.1 Held environmental water in Victoria

In the Victorian context, held environmental water is any water held under an entitlement for an environmental purpose. This water includes:

- Environmental entitlements or bulk entitlements issued to the Victorian Environmental Water Holder (VEWH) to provide water to be used for environmental purposes.
- Entitlements such as take and use licences or water shares held by the VEWH or CEWH.
- A passing flow specifically allocated to the holder in an environmental entitlement for environmental benefit or purpose.

This water is considered held environmental water under the Commonwealth definition because it is water specifically committed to environmental purposes under a water access right.

Held environmental water is protected by Victoria's water entitlement framework, which provides security to all entitlement holders, regardless of use. Held environmental water can be equivalent to high-reliability entitlement or low-reliability entitlement, or it can be provisional and have reliability as described in the bulk or environmental entitlements.

Held environmental water is protected by the Victorian entitlement framework, which provides for:

- Secure and enduring entitlements.
- The limits on take through sustainable diversion limits and permissible consumptive volumes.
- The clear consultative process for changing entitlements.
- The annual process to allocate water to entitlements.
- The ability to trade.
- Ministerial intervention only during extreme events to ensure supplies for critical human water needs.
- A regime for compliance and enforcement.

All entitlements in Victoria are recorded on the Victorian Water Register (https://www.waterregister.vic.gov.au/water-entitlements). Information about the holder of the entitlement, where the water may be taken and used, and the volumes authorised by the entitlement, are described in this register.

Section 3.5 describes how environmental watering objectives are achieved through the use of held environmental water and supported by planned environmental water or water not otherwise allocated in the system, including minimum passing flows for system water. Protection and rules for passing or minimum flow obligations are outlined in the respective bulk or environmental entitlement instrument for each system.

The use of held environmental water is often closely integrated with other types of water use. The VEWH works closely with catchment management authorities and storage managers and, where practical, seeks opportunities to adjust the timing and route for delivering consumptive water to achieve environmental objectives efficiently. This can include 'piggy-backing' delivery of environmental water on the delivery of consumptive water or passing flow obligations to maximise ecological outcomes.

Held environmental water in the Northern Victoria water resource plan area is summarised in Table 18.

4.2.2 Planned environmental water in Victoria

Section 10.09(1) of the Basin Plan requires the identification of planned environmental water. A review of Victoria's bulk entitlements and statutory management plans in Victoria's North and Murray water resource plan area was undertaken to determine where planned environmental water was in northern Victoria. The review looked for water that met the *Water Act 2007* (Cth) requirements that:

- The water is committed or preserved.
- The commitment or preservation is specifically set aside for achieving environmental outcomes either for a specific environmental purpose or environmental purposes more generally.
- The water that is committed or preserved cannot be taken for another purpose because it is protected from other forms of take or use.

In Victoria these conditions are not met in some bulk entitlements and systems as:

- Minimum passing flows are generally not preserved exclusively for an environmental purpose or outcomes as specified in section 6 of the *Water Act 2007* (Cth). Passing flow requirements tend to serve multiple outcomes as shared benefits and are rarely identified as being solely for an environmental purpose.
- Where water is committed or preserved or required to exist within the system, such as a minimum passing flow for a specified environmental purpose or to meet a specific environmental outcome, the Commonwealth definition deems that committed or preserved water cannot be taken for any other purpose. In Victoria, this requirement cannot be met where a water user has a right to take water for domestic and stock purposes and it is not accounted for in measuring passing flow.

There are three instances in Victoria's North and Murray water resource plan areas where instruments meet the Basin Plan definition of planned environmental water. These are:

- Minimum passing flows available under the Bulk Entitlement (Broken System – Goulburn-Murray Water) Conversion Order 2004.
- Minimum passing flows available under the Bulk Entitlement (Ovens System – Goulburn-Murray Water) Order 2004.
- Minimum passing flows available under the Upper Ovens River water supply protection area water management plan (GMW, 2012).

Planned environmental water in Victoria's North and Murray water resource plan area is protected in two ways.

- Through the instruments that establish planned environmental water and the instruments that regulate water resource management in Victoria under the *Water Act 1989* (Vic); and
- Measures under the *Water Act 1989* (Vic) such as the Environmental Water Reserve and offences for taking water without authorisation.

These are considered 'rules and arrangements' relating to the planned environmental water and are identified in Table 29 of Appendix E of the Victoria's North and Murray water resource plan (DELWP, 2020). The water resource plan also provides further details on planned environmental water in Victoria.

Table 18. Summary of environmental water holdings relevant to the Northern Victoria water resource plan area as of 30 April 2021

System	Entitlement	Volume (ML)	Class	Holder	Notes
Broken	CEWH water shares	534	High	CEWH	
		4	Low		
	VEWH water shares	90	High	VEWH	
		19	Low		
Campaspe	Environmental Entitlement (Campaspe River – Living Murray Initiative) 2007	126	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA
		5,048	Low		
	Campaspe River Environmental Entitlement 2013	20,652	High	VEWH	
		2,966	Low		
	CEWH water shares	6,624	High	CEWH	
		395	Low		
Goulburn	Goulburn River Environmental Entitlement 2010	26,555	High	VEWH	
		5,792	Low		
	Environmental Entitlement (Goulburn System – Living Murray) 2007	39,625	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA.
		156,980	Low		
	Environmental Entitlement (Goulburn System – NVIRP Stage 1) 2012	N/A	Provisional	VEWH	Water is allocated to VEWH annually in line with procedure for determining mitigation water in Schedule 3 of the Bulk Entitlement (Eildon – Goulburn Weir) Conversion Order 2005
	Silver and Wallaby Creeks Environmental Entitlement 2006	N/A	Passing flow only	VEWH	
	CEWH water shares	317,557	High	CEWH	
		42,467	Low		
	The Living Murray - water shares	5,559	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA
Loddon		10,970	High	VEWH	

System	Entitlement	Volume (ML)	Class	Holder	Notes
	Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005	2,024	Low		The entitlement includes passing flows in addition to a volumetric entitlement.
		N/A	Passing flow only		
	Environmental Entitlement (Birch Creek – Bullarook System) 2009	100	Provisional	VEWH	The entitlement includes passing flows in addition to a volumetric entitlement. Allocation to these entitlements is made subject to specific triggers, as specified in the entitlement.
	CEWH water shares	3,356	High	CEWH	
		527	Low		
Ovens	CEWH water shares	123	High	CEWH	
Murray	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999	45,267	High	VEWH	
		8,523	Low		
		49,000	Provisional		Rules allow 40,000 ML of this entitlement to be borrowed to support high-reliability entitlements.10,000 ML must be made available for low-level watering at Barmah Forest.
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – River Murray Increased Flows	N/A	Provisional	VEWH	Rules in the Bulk Entitlement (River Murray - Flora and Fauna) Order 1999 describe access rights for RMIF.
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Barmah-Millewa Forest Environmental Water Allocation	50,000	Provisional	VEWH	
		25,000	Provisional		
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Living Murray	9,589	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA.
		101,850	Low		
		34,300	Provisional		
	Environmental Entitlement (River Murray – NVIRP Stage 1) 2012	N/A	Provisional	VEWH	Water is allocated to VEWH annually in line with procedure for determining mitigation water in Schedule 3 of the *Bulk Entitlement (Eildon – Goulburn Weir) Conversion Order 2005*
	CEWH water shares	362,360	High	CEWH	
		35,413	Low		
	The Living Murray – water shares	12,267	High	VEWH	The Living Murray entitlements are held by the VEWH in trust for the MDBA

Note: The Northern Victorian and Victorian Murray water resource plan areas are highly connected allowing water sourced in one water resource plan area to be used in another. Water trading allows VEWH to move water to the systems where it is most needed and manage some of the variability within systems. In some systems, environmental water delivered through upstream sites can be used at downstream sites – the water credited to VEWH accounts at downstream sites is called return flows.

4.2.3 Other water that contributes to environmental outcomes

The previous section (and Victoria's North and Murray Water Resource Plan (DELWP, 2020) explains what planned environmental water is, and is not. Although there is other non-held water in Victoria's waterways that also contributes to environmental objectives for priority environmental assets and ecosystem functions, this water does not fall under the definition of planned environmental water as it is not specifically committed for environmental purposes and provides shared benefits. For example, system operating water (the water released from storages to operate river and distribution systems) benefits the environment but also allows delivery of water to other users. Similarly, above-cap water (the water left over after the upper limits on diversions have been reached, including unregulated flows that cannot be kept in storage) provides significant benefits to the environment but also to recreational users of waterways.

Water for Victoria (2016) sets out Victoria's position on optimising the use of limited water resources to meet some of the objectives of key groups in the community, such as Traditional Owners and Aboriginal Victorians, and recreational users. CMAs and the VEWH are required to consider shared benefits when making environmental watering decisions.

Environmental water managers work with river operators to identify how all types of water can be best utilised to meet multiple objectives, including those for the environment. They coordinate the delivery of held environmental water with above cap and system water, as well as planned environmental water and consumptive water *en route*, to meet environmental objectives. Sometimes the timing and route for delivery of consumptive water can be altered to achieve environmental objectives without using environmental water.

4.3 Regulated systems of the Northern Victoria water resource plan area

Most of the major rivers in the Northern Victoria water resource plan area are regulated, and these are listed in Table 19. The volume of water available in the held entitlements in each system varies in any given year due to seasonal conditions, including rainfall and runoff in the catchments. At 30 April 2021, the VEWH's Water Holdings equated to an expected long-term average of 711 GL across Victoria.

Table 19: Regulated systems in the Northern Victoria water resource plan area

System	Description	Comments
Ovens/King	Flows are regulated by Lake Buffalo on the Buffalo River (major tributary of the Ovens River) and Lake William Hovell on the King River. Regulated flows extend downstream from the storages to the confluence of the Ovens River with the Murray at Lake Mulwala.	These systems are sometimes referred to as semi-regulated, as much of the flow originates from unregulated tributaries or spills through the two storages. Flows in the system are supplemented by storage releases during drier months, typically December to March.
Broken	Flows are regulated by Lake Nillahcootie on the Broken River and Casey's Weir, right through to its confluence with the Goulburn River at Shepparton. Flow is diverted at Casey's weir into the Upper Broken Creek.	The extent of regulation in this system has decreased following the decommissioning of Lake Mokoan to generate environmental water savings.
Goulburn	Flows are regulated by Lake Eildon, and Goulburn Weir on the Goulburn River. Waranga Basin is a major off-stream storage filled by flows diverted at Goulburn Weir and can be used to meet irrigation demands in the Goulburn component of the Goulburn Murray Irrigation District. The Goulburn River is regulated from Lake Eildon right through to its confluence with the River Murray.	The Goulburn catchment is one of the major supply sources for irrigation in the Shepparton, Central Goulburn, Rochester and Loddon Valley Irrigation Areas. Water is diverted from the Goulburn river and supplied via the Waranga Western Channel to the Central Goulburn, Rochester and Loddon Valley area. Supplementary supplies can be diverted into the Waranga Western Channel from the Campaspe River and the Loddon River.

System	Description	Comments
Campaspe	Flows are regulated by Lake Eppalock and Campaspe Weir on the Campaspe River. The Campaspe River is regulated from Lake Eppalock through to its confluence with the River Murray.	The Campaspe system supplies irrigation demands on the Campaspe River and via supplements delivered to the Waranga Western Channel. It supplies and urban demands for Bendigo. There are significant environmental entitlements which were established in part with water acquired as part of the decommissioning of the Campaspe Irrigation District.
Coliban	Flows are regulated by Upper Coliban, Lauriston and Malmsbury reservoirs on the Coliban River, which is a tributary of the Campaspe River upstream of Lake Eppalock. The Coliban River is regulated from Upper Coliban through to Malmsbury Reservoir (see comments)	The Coliban system supplies rural water and urban water needs to the Bendigo region. No water is released downstream of Malmsbury Reservoir into the Coliban River for consumptive purposes; however, environmental entitlements are available and can be released from Malmsbury Reservoir into the Coliban River.
Loddon	Flows are regulated by Cairn Curran Reservoir and Laanecoorie Reservoir on the Loddon River and Tullaroop Reservoir on the Tullaroop Creek. Tullaroop Creek enters the Loddon upstream of Laanecoorie Reservoirs. The Loddon River is regulated from Cairn Curran and Tullaroop reservoirs through to Loddon Weir near Boort (see comments).	The Loddon system supplies irrigation demands on the Loddon River and via supplements delivered into the Waranga Western Channel at Loddon Weir. Supplies are not released downstream of Loddon weir for consumptive purposes, but environmental releases can be made into the reach downstream of Loddon weir if required.

4.4 Unregulated surface water systems of the Northern Victoria water resource plan area

The majority of the smaller streams and rivers in the water resource plan area are unregulated. In the Northern Victoria water resource plan area, a range of water management arrangements have been developed for these unregulated streams.

As described in Section 4.2.2 above, a water supply protection area has been declared for the Upper Ovens River, and a water management plan has been developed. This plan is an integrated water management plan, which recognises and jointly manages both surface water and groundwater. Local management rules have been developed and published for virtually all other significant unregulated streams in the water resource plan area.

4.5 Groundwater systems

Groundwater in Victoria is managed through statutory Groundwater Management Plans and non-statutory local management plans. Such plans apply caps (or 'permissible consumptive volumes' (PCVs)) on extraction within a groundwater management area and, through licences that share water amongst users, ensure protection of environmental values. These plans particularly protect values associated with groundwater-dependent ecosystems (GDEs) that rely on groundwater for all or part of their water needs (e.g. river reaches that gain or lose groundwater, wetlands that rely on shallow aquifers, or terrestrial vegetation that relies on shallow or deeper aquifers).

In addition to planning processes for managing unregulated surface water entitlements, the Ministerial Guidelines for Groundwater Licensing and the Protection of Groundwater Dependent Ecosystems (DELWP, 2015) oblige water corporations to undertake a structured assessment of the risks to GDEs associated with the issue or transfer of a groundwater licence. For medium or high-risk proposals, suitable risk mitigation treatments must be developed and incorporated in licence conditions; a licence application may be refused if suitable mitigations are not available. These guidelines support and complement the objectives of the surface water management processes in unregulated catchments to protect and enhance environmental conditions.

4.5.1 Groundwater dependency of priority environmental assets

The hydrogeology of the water resource plan area is broadly subdivided into two distinct geological regions (DELWP, 2020). The first is the southern highlands region features exposed bedrock and valleys of eroded material that form the Quaternary Aquifer. This thin, shallow aquifer made up of sand, colluvium, fluvial sands, gravels, clay and silts is found in upland valleys such as Alexandra, Yea and Flowerdale. Water is also held in the Mesozoic and Palaeozoic basement rock, which is close to the surface near Jamieson, Mansfield, Marysville, Kilmore and Seymour.

The other geological region (DELWP, 2020) is the northern floodplain of the Ovens, Broken, Goulburn, Campaspe, Loddon and Murray rivers. It includes the Upper Tertiary Quaternary Aquifer (UTQA) of the Shepparton formation of layered clay, sands and silt that runs from near Seymour north to Nathalia, Barmah and Numurkah. Along the River Murray, the UTQA overlies the Calivil Formation Upper Tertiary Aquifer fluvial, containing fluvial sand, gravel and clay. Other formations include the Lower Tertiary Aquifers of the Renmark formation near Nathalia and Barmah, and Cretaceous Permian sediments made of fractured rock, sand and minor coal near Shepparton to parts of the north near Nathalia and Numurkah.
Victoria's North and Murray Water Resource Plan (DELWP, 2020) identified the groundwater-dependent priority environmental assets in the Northern Victoria water resource plan area
(
Table 20 and Table 21). In addition, Groundwater Logic (Groundwater Logic, 2019) assessed risks to ecosystem values associated with groundwater resource use and considered whether the priority environmental assets are sufficiently protected from such risks by the provisions of existing groundwater management plans.

Whilst the confidence assigned to groundwater dependence varied from high to low, the level of risk posed by groundwater resource use was generally assessed as low for priority environmental assets across northern Victoria (Groundwater Logic, 2019). Only four river reaches and one wetland have been classified as moderate risk GDEs, but all are in areas with existing water management protections in place (e.g. ongoing groundwater usage restriction triggers in place under the Local Management Plan, or where there are baseflow-related targets for environmental watering). Groundwater dependent wetlands were all considered to be at low risk from groundwater extraction. Overall, existing measures were considered sufficient to protect priority environmental assets from excessive groundwater resource use.

Table 20: Groundwater dependent priority environmental assets (rivers and streams) in the Northern Victoria water resource plan area (DELWP, 2020)

PEA name	PEA reach	Index of Stream Condition Basin-Reach	Surface water SDL resource unit	Groundwater dependent features (confidence)
Birch's (Bullarook) Creek	Birch Creek R21	44378	SS8 (Loddon)	H
Broken River	Broken and Nine Mile R22	44652	SS5 (Broken)	H
	Broken River R2	43135	SS5 (Broken)	H
	Broken River R3	43163	SS5 (Broken)	Non-GDE
	Broken River R4	43194	SS5 (Broken)	H
	Broken River R4	43194	SS5 (Broken)	L
Campaspe River	Campaspe River R1	43106	SS2 (Victorian Murray)	H
	Campaspe River R2	43137	SS7 (Campaspe)	H
	Campaspe River R3	43165	SS7 (Campaspe)	Non-GDE
	Campaspe River R4	43196	SS7 (Campaspe)	Non-GDE

PEA name	PEA reach	Index of Stream Condition Basin-Reach	Surface water SDL resource unit	Groundwater dependent features (confidence)
	Campaspe River R5	43226	SS7 (Campaspe)	M
Coliban River	Coliban River R18	43252	SS7 (Campaspe)	M
	Coliban River R19	43617	SS7 (Campaspe)	M
Goulburn River	Goulburn River R1	43105	SS6 (Goulburn)	H
	Goulburn River R2	43136	SS6 (Goulburn)	H
	Goulburn River R3	43164	SS6 (Goulburn)	Non-GDE
	Goulburn RiverR4	43195	SS6 (Goulburn)	H
	Goulburn River R5	43225	SS6 (Goulburn)	H
	Goulburn River R6	43256	SS6 (Goulburn)	H
	Goulburn River R7	43286	SS6 (Goulburn)	H
	Goulburn River R8	43317	SS6 (Goulburn)	H
	Goulburn River R9	43348	SS6 (Goulburn)	L
	Goulburn River R10	43378	SS6 (Goulburn)	H
	Goulburn River R11	43409	SS6 (Goulburn)	M
	Goulburn River R12	43439	SS6 (Goulburn)	H
	Goulburn River R13	41395	SS6 (Goulburn)	H
	Goulburn River R14	41760	SS6 (Goulburn)	H
Loddon River (upper)	Loddon River upper R6	43258	SS8 (Loddon)	Non-GDE
	Loddon River upper R7	43288	SS8 (Loddon)	H
	Loddon River upper R8	43319	SS8 (Loddon)	M
	Loddon River upper R18	43282	SS8 (Loddon)	M
Loddon River (middle)	Loddon River middle R2	43138	SS8 (Loddon)	Non-GDE
	Loddon River middle R4	43197	SS8 (Loddon)	H
	Loddon River middle R5	43227	SS8 (Loddon)	H
Ovens River (including Buffalo River)	Buffalo River R33	15401	SS4 (Ovens)	H
Ovens River (including King River)	King River R21	44256	SS4 (Ovens)	M
	King River R22	44621	SS4 (Ovens)	M
	King River R23	44986	SS4 (Ovens)	M
	King River R24	45352	SS4 (Ovens)	M
Ovens River	Ovens River lower R1	43103	SS4 (Ovens)	H
	Ovens River lower R2	43134	SS4 (Ovens)	H
	Ovens River lower R3	43162	SS4 (Ovens)	L
	Ovens River lower R3	43162	SS4 (Ovens)	H
	Ovens River lower R4	43193	SS4 (Ovens)	H

PEA name	PEA reach	Index of Stream Condition Basin-Reach	Surface water SDL resource unit	Groundwater dependent features (confidence)
	Ovens River lower R4	43193	SS4 (Ovens)	L
	Twelve Mile Creek	NA	SS4 (Ovens)	Non-GDE

Table 21: Groundwater dependencies - wetlands in the Northern Victoria water resource plan area (DELWP 2020)

PEA Name	Index of Wetland Condition ID	Surface water SDL resource unit	Groundwater-dependent features (confidence)
Moodies Swamp	67053	SS5	M

5. Cooperative arrangements

Environmental water management involves a range of people and organisations. This section describes these partnerships and identifies the processes by which collaboration occurs between agencies and across regions.

5.1 Context

There are strong cooperative arrangements in place to support delivery of Victoria's environmental watering program, between environmental water holders (VEWH, CEWH, TLM), managers of water regulations (water corporations), managers of priority environmental assets (water corporations, CMAs, land management agencies) and community members. Environmental water holders, water corporations, CMAs and land management agencies partner with the relevant Traditional Owner groups to deliver Victoria's environmental watering program.

The Victorian government has established these arrangements, in consultation with delivery partners and communities, and participates in inter-jurisdictional arrangements, through the Southern Connected Basin Environmental Watering Committee (SCBEWC) and newly formed Environmental Watering Committee (EWC, formed in 2021). The arrangements are underpinned by a range of policy, regulatory and governance frameworks.

5.2 Responsible organisations

Public and private authorities collaborate to deliver environmental water in Victoria. These authorities, referred to as program partners, are listed in Appendix G along with their respective roles and responsibilities, which are summarised as follows:

- **Waterway managers** (CMAs) are responsible for identifying, planning and implementing regional priorities for environmental waterway management, this includes identifying objectives and assessment of water regimes needed for priority environmental values, Aboriginal cultural values and uses, social and recreational uses and values and economic values. They consult with local communities, develop proposals for environmental watering in rivers and wetlands in their region, order environmental water from storage managers, and monitor the outcomes. In the Northern Victoria water resource plan area, the responsible CMAs are North Central, Goulburn Broken, and North East CMAs. In addition, SCBEWC was formed in 2014 to coordinate the delivery of environmental water across the southern Murray-Darling Basin (see Section 5.3, below).
- **Storage managers** (water corporations) deliver water for all water users, including for waterway managers / environmental water holders. In the Northern Victoria water resource plan area, Goulburn-Murray Water is the responsible water corporation.
- **Environmental water holders** commit environmental water to different rivers and wetlands. They work together to ensure the coordinated delivery of water available under different environmental entitlements, and often have to prioritise across large regions or water resource plan areas. In the Northern Victoria water resource plan area, the environmental water holders are VEWH, CEWH and TLM.
- **Public land managers** are closely involved in environmental water planning and delivery for public land such as state forests or national parks. They may have a variety of responsibilities including operating infrastructure (such as pumps, outlets, gates and channels) and ensuring appropriate public signage during an event. In the Northern Victoria water resource plan area the public land managers are Parks Victoria, DELWP, and Traditional Owner land management boards.
- **Private land holders and other community members** are actively involved in environmental water planning, for example through involvement in seasonal watering proposal advisory boards or in co-operative management of wetland assets (e.g. Wirra-Lo wetland complex, (NCCMA, 2014)).

- **Traditional Owner groups** in the Victorian Murray water resource plan area include the First Peoples of the Millewa-Mallee Aboriginal Corporation and the Yorta Yorta Nations Aboriginal Corporation. In Victoria, there are currently three different processes for groups to become formally recognised as Traditional Owners of Country. This includes Registered Aboriginal Party (RAP) under the *Aboriginal Heritage Act 2006*, Native Title Determination under the *Commonwealth Native Title Act 1993* and Recognition and Settlement Agreement under the Victorian *Traditional Owner Settlement Act 2010*. Waterway managers, storage managers and environmental water holders partner with formally recognised Traditional Owners and work with other Traditional Owner groups to support recognition of Aboriginal values and uses in waterway management.
- **MLDRIN and the Federation of Victorian Traditional Owner Corporations** also play important roles in advising on diverse matters related to water management.

5.3 Coordination processes

Coordination of environmental watering in the surface water systems in the Northern Victoria water resource plan area, and across Victoria's state borders, is done through cooperative arrangements. The Victorian Environmental Water Holder leads annual environmental water planning and coordination for Victorian waterways at a water resource plan area scale, in close consultation with catchment management authorities as the local environmental water managers.

The VEWH represents the Victorian priorities and objectives at interstate and Commonwealth environmental watering coordination forums to help align and coordinate objectives and outcomes at the broader Murray-Darling Basin scale.

The VEWH works closely with the CEWH in areas where Commonwealth water holdings may be used in Victoria. The VEWH and CEWH have an agreement to collaborate and coordinate their activities (DELWP, 2020). The VEWH also collaborates closely with CMAs and water corporations (e.g. Goulburn-Murray Water) in the planning and delivery of environmental water at local and regional scales as part of its annual watering planning process.

The VEWH's annual seasonal watering plan outlines the annual watering priorities of the entire State. The process for development of the seasonal watering plan is shown in Figure 13**.**

This process works year-round as follows:

- **Dec-Mar:** CMA planning and consultation to begin preparation of Seasonal Watering Proposals for the coming water year. Waterway managers prepare seasonal watering proposals before the preceding season. These are informed by their regional waterway strategies, environmental flow studies, and environmental water management plans. The proposals are developed in consultation with the community, Traditional Owners and other partners.
- **Apr-May**: The CEWH and VEWH prepare a seasonal watering plan based on seasonal watering proposals. This involves consultation with MDBA and the jurisdictions (e.g. through SCBEWC – see below) prior to the preceding season.
- **Jun**: Release of Seasonal Watering Plan.
- **Jul-Jun** (year-round): Program partners coordinate delivery of environmental water. Throughout the season, the VEWH issues seasonal watering statements to waterway managers to authorise water use and to communicate environmental watering decisions.

Seasonal watering statements issued to the North Central, Goulburn-Broken and North East CMAs are available online at http://www.vewh.vic.gov.au/news-and-publications/seasonalwateringstatements.

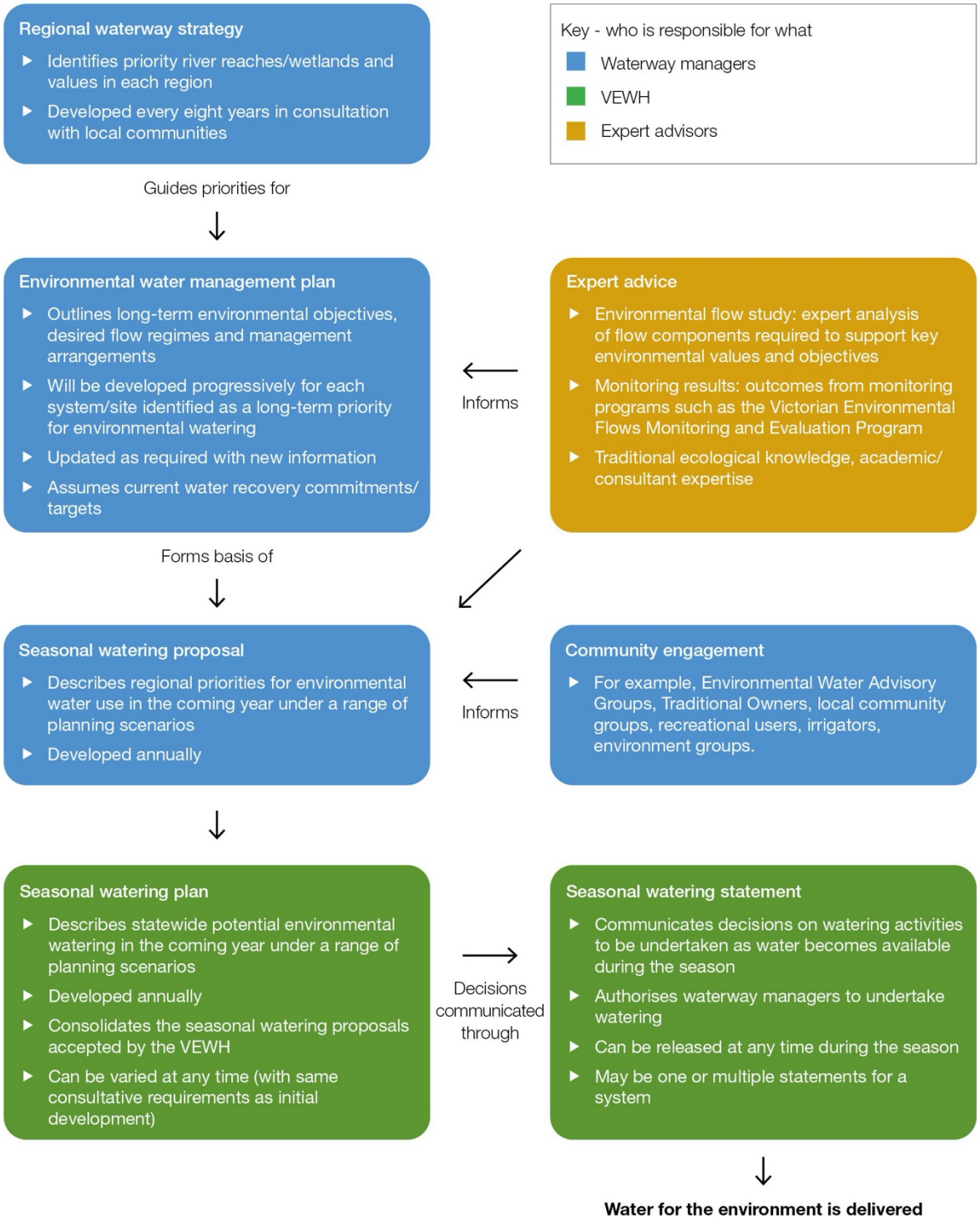


Figure 13: Victoria's annual environmental water planning process (VEWH, 2020)

Ongoing and regular communication between environmental water holders, storage managers and environmental water managers provides opportunities to discuss priorities, negotiate watering commitments, review watering actions, report on outcomes and to integrate environmental watering into system operations to optimise outcomes, for example in planning to reuse return flows for watering at multiple sites. This is often achieved through Operational Advisory Groups that bring together site managers, river operators and environmental water holders to coordinate water use.

Inter-jurisdictional cooperation also occurs at multi-jurisdictional scales through the Southern Connected Basin Environmental Watering Committee (SCBEWC). The SCBEWC was established in 2014 to coordinate and integrate the delivery of environmental water in the southern connected Basin and oversee the planning and delivery of TLM environmental water. SCBEWC has a particular focus on the River Murray System, including the allocation and management of TLM portfolio, consistent with Basin Plan Environmental Water

Plan and its objectives, in order to meet the overall Basin Plan targets (outlined in Section 1.1). Members include the MDBA (including River Murray Operations); Commonwealth Department of Agriculture, Water and the Environment; CEWH; NSW Office of Environment and Heritage; NSW Office of Water; SA Department for Environment and Water; VEWH; and Victorian DELWP. SCBEWC meets at least four times each year to coordinate environmental water planning, approximately:

- Feb-Mar: start of environmental water holders planning for the following water year
- Apr-May: towards the end of water year once Basin and Catchment annual environmental water proposals and priorities have been drafted – to evaluate watering actions undertaken to date and develop an operational strategy for the following water year that seeks to coordinate environmental water delivery for system outcomes.
- Jun: at the end of the water year to consider water actions for the following water year that contribute to these priorities and system wide benefits
- Aug: to re-evaluate proposed watering actions based on actual flow conditions; and consider actions for the remainder of the water year.

Additional meetings are held to coordinate watering activities in the southern connected system, inform decisions during watering events and/or make decisions on the use of TLM portfolio.

The MDBA's 2017 evaluation of the Basin Plan found that by 2016-17, over a third (37%) of all environmental watering events in the basin were coordinated events involving multiple environmental water holders. Increased collaboration is seeing environmental water managers combine their water to deliver larger and more effective events than would otherwise be possible.

The effectiveness of these cooperative coordination processes is demonstrated by the southern winter-spring flow of 2019 when environmental water releases from Lake Hume and Lake Eildon were coordinated to deliver large spring flows in the Murray and Goulburn rivers and through six Living Murray icon sites including the Coorong and Lower Lakes in South Australia. The initial flow commenced in August 2019 and was timed to coincide with natural seasonal increases in river flow. Carefully watching weather events, waterway managers halted the flow when high rainfall in the Ovens and Kiewa catchments provided large natural flows to the Murray River. A second release of environmental water commenced in September 2019 and, through careful planning, storage managers and waterway managers were able to time the release to meet with a flow delivery in the Goulburn River.

5.4 Traditional Owners

The Basin Plan requires that environmental water planning maximises benefits and effectiveness by including Traditional Owner values, uses and aspirations for water in planning and management. Sections 10.53 and 10.54 require Basin States to identify objectives and outcomes of water based on Aboriginal values and uses of water and have regard to the views of Aboriginal organisations.

To deliver on this requirement, DELWP engaged with local Traditional Owner groups during 2018 and 2019 to document their water-related aspirations during the development of Victoria's North and Murray Water Resource Plan (DELWP, 2020). Groups consulted with an interest in this water resource plan area included Bangerang, Barapa Barapa, Dhudhuroa, Waywurru, Yaitmathang, Dja Dja Wurrung, First Peoples of Millewa Mallee (Nations of the Nyeri Nyeri, Ngintait and Latji Latji), Tati Tati Wadi Wadi, Taungurung, Wadi Wadi, Wamba Wemba, Weki Weki and Yorta Yorta.

Engagement was staged and tailored to consider and respect the preparedness, prioritisation and resourcing of each individual Traditional Owner group. Different mechanisms were used, depending on individual preferences, including workshops, meetings, Nation meetings, community gatherings and information sharing on Country.

The engagement process aimed to identify objectives and desired outcomes for water resources, support celebrating and sharing culture and traditional practices within Traditional Owner groups, discuss economic development opportunities and build relationships and Traditional Owner organisational and community capacity. The engagement process and feedback from Traditional Owners is documented in Chapter 8 and Appendix D of the Victoria's North and Murray Water Resource Plan (DELWP, 2020).

The Victorian Government has also taken steps over the past few years to increase participation of Traditional Owners and Aboriginal Victorians in water management across the state, through legislative

changes and the introduction of new programs. In 2019, the *Water Act 1989* (Vic) and *Catchment and Land Protection* Act *1994* (Vic) were amended (*Water and Catchments Amendment Bill 2019*) to establish a greater recognition and involvement of Aboriginal Victorians in the planning and management of waterways and catchments. The amending bill requires relevant statutory agencies to:

- include, where possible, Aboriginal Victorians in consultative committees and on the Victorian Catchment Management Council;
- consult with Traditional Owner groups for the preparation of management plans and strategies for waterways and catchments; and
- incorporate Aboriginal values and traditional ecological knowledge in the management of waterways and catchments.

Funding is also provided directly to Traditional Owners and Aboriginal Victorians to support self-determination in water management through DELWP's Water, Country and Community Program (formerly called the Aboriginal Water Program). The program funds self-determined water related projects and Aboriginal Water Officers (or their equivalents) in Traditional Owner organisations and CMAs across Victoria. This approach aims to provide Traditional Owners and Aboriginal Victorians with the necessary resources to be involved in the environmental water program and broader water management, planning processes and decisions.

Importantly, Traditional Owners are increasingly involved in all aspects of Victoria's environmental watering program, including the annual and long-term planning process. In the past two years DELWP has been seeking to strengthen this involvement by engaging with Traditional Owners across northern Victoria about the LTWP and EWMP processes. Groups engaged to date with an interest in this water resource plan area have included the Barapa Barapa, Dja Dja Wurrung, Taungurung, Wamba Wemba and Yorta Yorta. Due to COVID-19 restrictions during 2020, engagement was largely online and via phone and email. Grants were offered to assist Traditional Owner groups to make submissions on the EWMP guidelines and were taken up by several groups.

This work is ongoing, and feedback will be integrated into the EWMP guidelines to support increased participation of Traditional Owners and provide the opportunity for cultural exchange during the EWMP planning process. For example, traditional knowledge, place names and cultural objectives may be included in EWMPs, where this is desired by Traditional Owners. The Aboriginal Waterway Assessment[7] tool can be used to facilitate this process. Further involvement of Traditional Owners at the regional level via the LTWPs will be facilitated, where desired, by Traditional Owners.

The VEWH has undertaken a number of steps to increase Aboriginal participation in the environmental watering program, this includes updating the SWP Guidelines in 2020 to better reflect CMAs responsibilities to engage with Traditional Owners in the development of individual SWPs under the *Water and Catchments Amendment Bill* 2019. The VEWH has also released a position statement on Traditional Owner involvement and how they are supporting self-determination.

TLM funds the Living Murrays Indigenous Partnership Program (IPP). The program provides funding to support the employment of four Indigenous Facilitators, one for each of Victoria's four icon sites (Barmah Forest, Gunbower Forest, Hattah Lakes, Lindsay-Mulcra-Wallpolla Islands) as well as priority projects and on-Country visits, this can include environmental watering and monitoring.

7.The Aboriginal Waterways Assessment tool is a methodology in use to identify key cultural and environmental values, provide a basis for informed management objectives, guide capture and recording of knowledge about the cultural values, uses and health of waterways and assist Aboriginal people to be more meaningfully involved in water planning processes on their Country.

6. Constraints

Environmental water delivery is subject to physical or operational (and management) barriers that limit the flows that can be delivered down rivers and the outcomes that can be achieved. This section identifies the key constraints in the Northern Victoria water resource plan area and strategies to manage or overcome these.

'Bank full' and overbank flows that connect rivers to their floodplains are critical to support a healthy river and floodplain ecosystem. These higher flows are needed to restore the health of floodplain vegetation and reconnect wetlands, rejuvenating habitat for the diverse range of animals that depend on these areas, and also provide an important productivity boost for rivers. The ability to deliver higher flows will contribute to achieving many of the ecological objectives and targets for the priority ecological assets of the Victorian Murray water resource plan area and are linked to the Basin Plan's Environmental Watering Plan objectives and the system-wide targets.

Modelling indicates that the additional environmental water recovered through the Basin Plan will allow low-lying floodplains to be watered, provided that physical and operational constraints are addressed to avoid impacts to private land, businesses, and public infrastructure. Watering the mid to upper floodplain would require more water and have greater third-party impacts. In many cases, the only way to water these areas will be by using environmental works to target high value sites (see Section 7.4).

Physical and operational (or management) constraints to environmental water delivery are defined below:

- **Physical constraints** are a natural formation or a physical structure, for example a pipe or channel, that limit the volume of water that can pass a given location (refer to Basin Plan, p. 8). Physical constraints also include things like roads, bridges and private land that would be inundated at higher flows, causing potential damage to crops or fences and affecting access.
- **Operational (or management) constraints** arise from the operating practices employed to manage water resources across the Basin, such as channel sharing, water accounting and the ability to order water from specific locations. Unlike physical constraints, these constraints cannot simply be resolved through infrastructure works, but require policy and procedural changes. An example of overcoming an operational constraint is where water accounting frameworks in Victoria have been updated to allow crediting of return flows from environmental water use, permitting achievement of multi-site watering from a single water release.

6.1 Constraints Management Strategy 2013 to 2024

The MDBA's Constraints Management Strategy (CMS) 2013 to 2024 (MDBA, 2013a) identified and prioritised physical and operational constraints across the Murray-Darling Basin, focusing on seven key areas including:

- Hume to Yarrawonga (Murray River)
- Yarrawonga to Wakool Junction (Murray River)
- Goulburn River (Victoria)
- Murrumbidgee River (NSW)
- Lower Darling River (NSW)
- Gwydir River (NSW)
- Lower Murray (SA).

The CMS (MDBA, 2013a) looked at ways to address these constraints, including raising the height of bridges to maintain access at higher flows, improving flood warning systems and purchasing flood easements to enable private land to be watered. The process carried out to inform the development of the CMS (MDBA, 2013a) is described further in Figure 14.

The outcomes that can be achieved in each reach will depend on the extent to which constraints can be addressed, and the links and interdependencies across these focus reaches. Projects to relax or overcome constraints in all key focus areas, except the Gwydir, are being delivered by the relevant Basin state governments. These projects, called 'constraints measures', are exploring the potential impacts of delivering

higher flows and how these can be addressed to support system-wide environmental outcomes through the reconnection of rivers to their floodplains. Working closely with affected communities will be critical to success. Further information about Victorian constraints measures is provided below (see Section 6.3.2).

In 2014, the MDBA, working with Basin states and communities, completed the first phase of the CMS — the pre-feasibility phase. This identified and prioritised important operational and management constraints, including their relationship to physical constraints, and set out to define and agree between the MDBA and each of the Basin governments the respective roles and responsibilities to progress priority operational and management constraints.

The CMS identified nine types of operational and management constraints for further consideration, and identified four that were considered to make the most significant difference to achieving environmental outcomes. These nine constraints are listed below, with the four priority constraints shown in bold:

1. **delivery of environmental water on top of other instream flows**
2. **channel capacity sharing**
3. timing of water availability
4. planned environmental water
5. **environmental water can be used throughout the length of a river**
6. **protection of environmental flows from extraction and re-regulation**
7. substitution of held environmental water with other water
8. coordinated planning and delivery of water delivery
9. current river management practices.

Figure 14: Pre-feasibility assessment of operational and management constraints in the CMS (MDBA, 2013a)

6.2 Constraints affecting the Northern Victoria water resource plan area

The operational and management constraints affecting the Northern Victoria water resource plan area can be broadly grouped into the following types, associated with:

- Channel/ watercourse capacity (i.e. the constraints due to insufficient flow capacity to meet both environmental and consumptive demands at key watering times).
- Consumptive water entitlement framework (i.e. the constraints imposed by the procedures and policies of the water supply system (which was designed to supply water for consumptive use)).
- Co-operative management (i.e. the constraints due to existing governance arrangements that have often been developed independently of environmental watering arrangements).
- Excess consumptive demand (i.e. the constraints preventing environmental water managers from reducing stream flow to environmental desirable levels at the expense of fulfilling consumptive demands).
- Geomorphic impacts (i.e. the constraints controlling rates of rise and fall which are designed to prevent degradation of the physical form of waterways).
- Travel time and attenuation (i.e. the long travel time and attenuation experienced by environmental flows, which constrains the ability to readily 'piggy-back' on other flows in the target reach).
- Flooding (i.e. the constraints arising from inundation of private land or public infrastructure).
- Outlet release capacity (i.e. constraints due to insufficient flow capacity through reservoir release valves).
- Storage capacity (i.e. constraints due to insufficient storage in weir pool to store, re-regulate and later release flows).

Of the types of constraints listed above, those associated with outlet release capacity and the consumptive water entitlement framework are most numerous (DELWP, 2020).

6.3 Strategies to manage or overcome constraints

6.3.1 Policy measures

According to the CMS, the most notable operational constraints affecting the southern connected Basin were the policy measures outlined in the Basin Plan (c7.15 (2)) to:

- Credit environmental return flows for downstream environmental use.
- Allow the call of HEW from storage during unregulated flow events.

The MDBA considered that implementation of these two policy measures would resolve a number of operational and management constraints and would be required to achieve the desired objectives of the Basin Plan and this LTWP. Provisions in the VEWH's bulk and environmental entitlements and obligations on Goulburn-Murray Water in its bulk entitlements now enable the above two policy measures and address these constraints. These arrangements allow use of environmental water to get the best environmental outcomes without impacting the security of supply to other entitlement holders. The MDBA has accepted that implementation of these policy measures is enduring, operational and transparent now that Victoria's water resource plans are accredited.

6.3.2 Victoria's Constraints Measures Program (CMP)

Victoria's Constraints Measures Program (CMP) includes two separate constraints measures:

- the Hume to Yarrawonga project, a joint proposal with NSW; and
- the new Goulburn project.

The Hume to Yarrawonga project is in the Victorian Murray WRP area. Victoria will also lead the engagement with potentially affected Victorian landholders as part of NSW's Yarrawonga to Wakool project, which primarily impacts upon NSW landholders as higher flows enter the Edward-Wakool River system.

The new Goulburn project targets in-channel flows and is part of the Northern Victoria WRP area. It aims to improve the ability to meet local environmental watering objectives and also to supply flows from the Goulburn River and its tributaries to the main stem of the River Murray.

The flows being targeted as part of the CMP are below minor flood level but will still affect people's lives and business and must be done sensibly together with landowners and local communities. Victoria recognises that any relaxation of constraints will pose third-party flooding related risks which can impact public and private land, infrastructure, stock and people.

The Victorian Constraints Measures Program, in line with Basin Ministers direction, will adopt a community-centric engagement approach to work at both a regional and system-scale to assess what is practical to deliver; the benefits and risks including under climate change, and whether there is likely community and Traditional Owner support for implementation. Proceeding beyond this stage will depend on the outcomes of this feasibility study to be completed in late 2022.

6.3.3 Enhanced Environmental Water Delivery project

The Enhanced Environmental Water Delivery (EEWD) project is being jointly delivered by Victoria, NSW and SA, working closely with the MDBA. It complements all constraints measures and aims to make the most efficient and effective use of available environmental water. The project will develop a coordinated delivery strategy, improvements to forecasting and planning tools as well as streamlining administrative process to improve the ability to respond to flow triggers. These products will support a longer-term approach to environmental water planning and delivery at the reach and system scale, to improve outcomes across the southern connected Basin.

The EEWD project will investigate the feasibility of coordinating managed flows throughout the southern connected Basin. While the changes described above will be important to optimise environmental outcomes without constraints relaxation, benefits will be greater if higher flows can be delivered. However, even with constraints relaxed to targeted levels, many high value sites are located even higher on the floodplain and cannot be watered effectively without using environmental works (see Section 7.4).

7. Complementary actions

Environmental water is only one component of the activities and works required to achieve the ecological objectives and targets, and overall waterway health. Complementary actions are vital to support the priority environmental assets and functions, and to meet the ecological targets of this plan.

The essential complementary actions to accompany the provision of a suitable watering regime in this water resource plan area can be categorised under the following themes:

- Riparian land management
- Supporting native fish
- Pest plants and animal management
- Works and measures
- Community connections
- Traditional Owners delivering complementary actions
- Climate change adaptation.

7.1 Riparian land management

The success of environmental watering programs is reliant on appropriate riparian land management. In particular, watering programs aimed at maintaining or improving riparian vegetation condition will require programs to protect riparian vegetation from uncontrolled stock grazing and other damage. Where vegetation has been destroyed or removed, revegetation with appropriate species may also be required.

The VWMS (DEPI, 2013b) establishes a framework to maintain and improve priority public and private riparian land. The main approach for achieving this is for government to provide incentives to landholders, principally through voluntary agreements with catchment management authorities, to assist landholders to undertake riparian management activities including fencing, revegetation and vegetation enhancement, weed management and the provision of off-stream stock watering infrastructure.

Regional priorities for riparian activities are detailed in CMA regional catchment strategies (RCS) and regional waterway strategies (RWS) which were developed in close consultation with their catchment communities. The VWMS also contains a range of other actions relating to the management of riparian land. This includes a number of actions regarding the administration and management of Crown frontages, fire behaviour and riparian land, development of guidelines for controlled grazing and floodplain fencing, and managing stock in waterways upstream of potable water offtakes. A major program for promoting riparian management across Victoria was the Regional Riparian Action Plan (DELWP, 2015). This has help to deliver improved riparian management across each of the CMA areas of this LTWP.

7.2 Supporting native fish

Success of fish outcomes is reliant on a variety of complementary measures.

The VWMS emphasises that high quality instream habitat is essential to support healthy populations of native fish, as well as for aquatic plants and other animals. While many aspects of instream habitat (e.g. channel form, instream vegetation) can be addressed with environmental water, large wood in rivers provides shelter, food sources and breeding sites for a variety of instream animals. Under the VWMS, large wood in streams will not be removed unless it is demonstrated to pose a serious risk to public safety or public infrastructure. In some cases, large wood may be reinstated into rivers to improve habitat conditions.

Instream barriers, such as weir and dams, are another key threat to native fish. They prevent native fish from moving upstream for spawning and recruitment, and larvae from drifting downstream to new habitats. The loss of fish to irrigation channels is also a major concern, as diversions for irrigation flows lure fish into

channels taking them out of rivers and creeks and getting them effectively lost from the breeding population. Several threatened native fish species are affected including silver perch, flat-headed galaxias, trout cod, Macquarie perch and Murray cod. The success of fish outcomes is reliant on provision of suitable fish passage. The VWMS outlines the management approach and issues associated with the river channel. This includes policies and actions related to the provision of fish passage in the river channel. The intent is that passage for native fish will be maintained or improved by minimising further loss of connectivity and improving fish passage at priority sites.

In line with the policies and actions included in the VWMS to provide suitable fish passage, the Victorian government has invested $17 million on five major projects to enable fish movement and improve connectivity at priority sites. In the Northern Victorian water resource plan area, this investment will address priority instream barriers in the Ovens River by constructing two fishways at Tea Garden Weir and Bright Weir to enable fish passage and access to over 270 km of additional important riverine and refuge habitat upstream of Tea Garden Creek, along the Ovens River and its major tributaries.

Native fish populations can also be supported by translocation of endangered species to new viable locations. Stocking of appropriate native species may also support this. The Victorian Fisheries Authority manages the stocking of waterways with recreational fishing species such as Murray cod, golden perch and silver perch, which can assist in meeting the objectives and targets outlined in this plan. Between December 2020 and March 2021 for example, golden perch have been released in the Ovens, Broken, Goulburn, Campaspe and Loddon river systems, Murray cod have been released in the Broken Creek system, and trout cod and Macquarie perch have been released in the Goulburn River system (see vfa.vic.gov.au) (VFA, 2021) .

7.3 Pest plant and animal management

The management of invasive species (plants or fauna) is a common environmental watering objective recognised by CMAs in EWMPs. Appropriate hydrological regimes can be used to dry out, flush or flood a species from a wetland or river, with varying degrees of success. However, some invasive species (e.g. carp) also can benefit from environmental flows and require other specific management actions.

The key actions in the VWMS that are closely linked to the LTWP are to develop an information system for planning, delivering and recording invasive species management activities, to provide results and outcomes that supply consistent data for performance and investment reporting, and to identify high-risk pathways for the spread of invasive species in waterways. Improvements in environmental conditions through various complementary actions, in addition to provision of appropriate flow regimes, will help native species to prosper over invasive species.

The management of existing and potential invasive species in Victoria is addressed under the *Invasive Plants and Animals Policy Framework* under Agriculture Victoria.

The CMA waterway strategies provide further information on management of invasive species. For example, the Goulburn Broken Waterway Strategy (GBCMA, 2014) identifies priority invasive species including introduced fish (e.g. carp (*Cyprinus carpio*), mosquito fish *(Gambusia affinis*)) and plant species (e.g. blackberry (*Rubus fruticosus*), cabomba (*Cabomba caroliniana*) and arrowhead (*Sagittaria* sp.)). Management actions are also outlined in waterway strategies, consistent with the VWMS (NCCMA, 2014), (NECMA, 2014), (MCMA, 2014).

7.4 Environmental works and measures

Natural flooding patterns can often be restored to fringing wetlands along the river and low-lying floodplain, but it is not possible to reinstate flooding to higher parts of the floodplain. This would require large volumes of water and could cause flooding that damages private land and public infrastructure, such as bridges and roads (refer to Section 6).

In many cases, environmental works like flow regulators, pumps and channels are the only way to get water to many of the sites that need it. This approach works when there is not enough water to flood wetlands naturally. Environmental works can enable ecological outcomes to be achieved with much smaller volumes of water than would be required to create a natural flood.

Works include infrastructure like pumps to supply water to disconnected wetlands, and regulators, channels and bunds to direct, retain or exclude flows. Other measures may also be needed, such as flood easements to allow for overbank flows or altering river operations to improve environmental outcomes. This approach ties closely in with constraints measures to improve overall environmental outcomes (see Section 6).

Large-scale environmental works have been completed through TLM and are already delivering results at three of Victoria's TLM icon sites in the Victorian Murray water resource plan area. New works proposals are being developed for nine sites in the Victorian Murray water resource plan area, through the Victorian Murray Floodplain Restoration Project (https://www.vmfrp.com.au/). This will enable another 14,000 ha of high-value wetlands and floodplain to be watered, effectively drought proofing these areas under climate change.

7.5 Community connections – recreational opportunities and better water literacy

Communities value their waterways. Waterways provide places to relax, holiday, exercise, fish, bird watch, hike and swim. Waterway managers are experiencing increased interest in nature-tourism in watered areas. Impacts from recreational activities are occurring and can be demonstrated. Nature based tourism, getting people out in nature, is part of the Victorian Government's Biodiversity Strategy titled 'Protecting Victoria's Environment – Biodiversity 2037' (DELWP, 2017).

To support enhanced community awareness regarding environmental watering, the Victorian government invests in a number of actions identified in:

- *Our Catchments Our Communities* strategy 2016-2019 (Goal 1 Effective community engagement in catchment management) (DELWP, 2019);
- The *Victorian Waterway Management Strategy* 2013 (2.4.6 Strengthening community partnerships in waterway management); and
- Chapter 7 (Recognising recreational values) of ***Water for Victoria*** *2016* (DELWP, 2016, pp. 111 - 122)

Complementary activities to support environmental watering include but are not limited to; community rehabilitation on riparian land and increased education and engagement to support local nature, tourism and recreational fishing opportunities.

7.6 Traditional Owners delivering complementary actions

Traditional Owners have cared for and sustainably managed Victoria's cultural landscapes for thousands of years. Traditional Owners have both a cultural obligation and a legal right to be custodians of their traditional land and waters and protect the unique natural and cultural values that they contain.

The Victorian Government is committed to enabling self-determination for Traditional Owners and Aboriginal Victorians through overarching policies and frameworks such as the Victorian Aboriginal Affairs Framework 2018 -2023 (Aboriginal Victoria, 2019) and Chapter 6 of Water for Victoria (DELWP, 2016, pp. 98 - 109).

CMAs are required under the *Water and Catchments Amendment Act 2019 to* recognise Aboriginal cultural values and knowledge in water and catchment planning and management and to include Traditional Owners in these processes. The 2016 Aboriginal Participation Guidelines for Victorian CMAs detail principles and commitments to engage and work with Traditional Owners and Aboriginal communities to manage and improve the health of lands and waters as well as supporting aspirations of rights, reconciliation, participation, employment and economic development through natural resource management.

An example of a complementary action is the 'A Healthy Coliban Catchment' project. NCCMA in partnership with Dja Dja Wurrung Clans Aboriginal Corporation, Coliban Water, Landcare and North Central Waterwatch undertook a project to protect the highly valued waterways and future water supplies of the Coliban Catchment by boosting habitat connectivity and building cultural and lifestyles values across the Coliban Catchment this includes the Coliban River (PEA in the Northern Victoria water resource plan area). The project works included: 300 kilometres of fencing to control stock adjacent to key waterways, revegetating the riverbanks, creating biodiversity corridors, funding off-stream watering alternatives for livestock and controlling invasive weeds including willows, blackberry, and gorse (NCCMA, 2019).

7.7 Climate change adaptation

The potential impacts of climate change and future land use change present major challenges to natural resource managers because they affect the environmental condition and values of ecosystems but are generally difficult to control. We know that climate change has the potential to affect environmental condition and the values that waterways support. There are many predictions about the effects of climate change, ranging from relatively low climate change effects to a continuation of the low streamflows seen during the extended drought between 1997 and 2009.

Protecting climate change refugia that can provide the opportunity for biota to weather the impacts of extended dry periods in localised, healthy systems from which they may expand from following drought is a necessary and pragmatic backstop. Without refugia, a severe drought would put at risk achievement of any ecological outcomes from watering.

Victoria's Water Sector Climate Change Adaptation Plan (WSAAP) is a pilot and was prepared in 2018, the purpose of the plan is to test the process of developing an Adaptation Action Plan. The Victorian Government is updating the pilot WSAAP and also leading the developing of other relevant plans including the Natural Environment Sector Adaptation Action Plan under the *Victorian Climate Change Act 2018.*

This program ties closely in with constraints indicated in Section 6, and supply measure projects to gain environmental outcomes using less water.

Further information about complementary actions in the Northern Victoria water resource plan area is detailed in the relevant CMA regional waterway strategies (e.g. (GBCMA, 2014), (NCCMA, 2014), (NECMA, 2014), (MCMA, 2014)).

8. Demonstrating outcomes

This section outlines how the targets set in Section 3 are measured. Wherever possible, monitoring draws upon existing programs to report on the objectives and targets for this water resource plan area.

8.1 Monitoring programs in Victoria

Victoria has two main environmental water monitoring programs, the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP), and the Wetland Monitoring and Assessment Program for environmental water (WetMAP). Both programs include monitoring that relates to the objectives and targets outlined in Victoria's long-term watering plans. This has direct links to objectives outlined in the EWMPs, as well as the objectives listed in both the BWS and in the Murray-Darling Basin Plan in Chapters 5 and 8, Schedules 7 and 8. The four-way alignment of objectives is laid out in Section 3.3, Table 8.

Other programs with monitoring relevant to Basin Plan outcomes include TLM, Victoria's Native Fish Report Card, and the CEWO's Monitoring, Evaluation and Research Program, or Flow-MER (replacing the Long-Term Intervention Monitoring program in 2020; note: the only site in Victoria is the Goulburn River). Victoria has invested in complementary monitoring using the Flow-MER program team to investigate the implications on the environment from unseasonal high flows over summer and autumn through delivery of consumptive water (e.g. inter-valley transfers of water to Sunraysia). This monitoring in conducted along the Goulburn River and the Campaspe River. Results from this monitoring have been beneficial for optimising outcomes from water delivery on bank condition and vegetation.

A range of these monitoring results are used by Victoria to report on Schedule 12 Matter 8, the 'achievement of environmental outcomes at an asset scale' (DELWP, 2020). This reporting commenced in 2020 under Basin Plan obligations and is required to be repeated every five years.

VEFMAP was established by the Victorian Government in 2005 to monitor and assess ecosystem responses to environmental watering in priority rivers across Victoria. Results from the program help inform decisions about environmental flow management by CMAs, Melbourne Water and the VEWH. VEFMAP has just completed its sixth stage of delivery (2016-2020), which included a strong focus on 'intervention' or 'flow-event' style questions related to vegetation and native fish. The approach used for VEFMAP Stage 6 provided much-needed information to support adaptive flow-management decisions in Victorian rivers. Stage 7 will adopt a similar approach, building on current knowledge and filling key gaps in understanding, leading to improved management outcomes that maximise our use of environmental water.

WetMAP was established in 2014 to investigate responses of wetland biota to environmental water management in Victorian wetlands. Monitoring for WetMAP Stage 3 (2016-2020) started in 2017 and focussed primarily on responses of vegetation, waterbirds, frogs and fish to environmental water deliveries in northern Victorian wetlands. WetMAP is now entering Stage 4 (2020-24), with planning focussed on identifying priority knowledge gaps for wetland water management.

The broad objectives for VEFMAP and WetMAP are to:

- Enable DELWP and its water delivery partners to clearly demonstrate the ecological value of environmental water management to the community and water industry stakeholders.
- Fill knowledge gaps to improve planning, delivery and evaluation of environmental water management in rivers and wetlands across Victoria.
- Identify ecosystem outcomes from environmental water to help meet Victoria's obligations under the Murray-Darling Basin Plan (Schedule 12, Matter 8).

Compliance monitoring is also undertaken. Where targets involve monitoring hydrological outcomes (flow or water quality), data collected through Victoria's Regional Water Monitoring Partnerships' program and the MDBA's water quality and flow monitoring programs can be used. Under these programs, surface water data is collected from approximately 780 monitoring sites across the State.

Community-based organisations conduct monitoring that are also used to evaluate environmental watering outcomes. These include Birdlife Australia monitoring, Waterwatch and Frogwatch.

There are also broader programs run by the MDBA aimed at the Basin scale, such as the Integrated Monitoring and Evaluation Program funded through Joint Programs and the Murray-Darling Basin Fish Survey (see MDBA's annual reports for more detail; https://www.mdba.gov.au/publications/mdba-reports/mdba-annual-report).

8.2 Improving outcomes

An adaptive management cycle has been adopted in Victoria to provide appropriate watering regimes for the environment and improve outcomes. This cycle (a simple version at an asset scale is illustrated in) includes:

- Ensuring environmental water is protected – this includes having appropriate policy and legislation in place (note this is higher level background to everything shown in Figure 15).
- Ensuring environmental water needs are understood and met (note this is not shown in Figure 15, but would consist of a parallel branch of learnings coming out from the monitoring and evaluation and feeding into the planning).
- Ensuring the water regime is managed to meet environmental objectives (planning and delivering water for the environment).
- Overcoming physical or operational constraints to enable best use of the water and maximise outcomes for the environment.
- Monitoring environmental flows and ecological responses to assess their effectiveness for meeting environmental objectives outlined in EWMPs.
- Reviewing the process to adapt and improve as required.

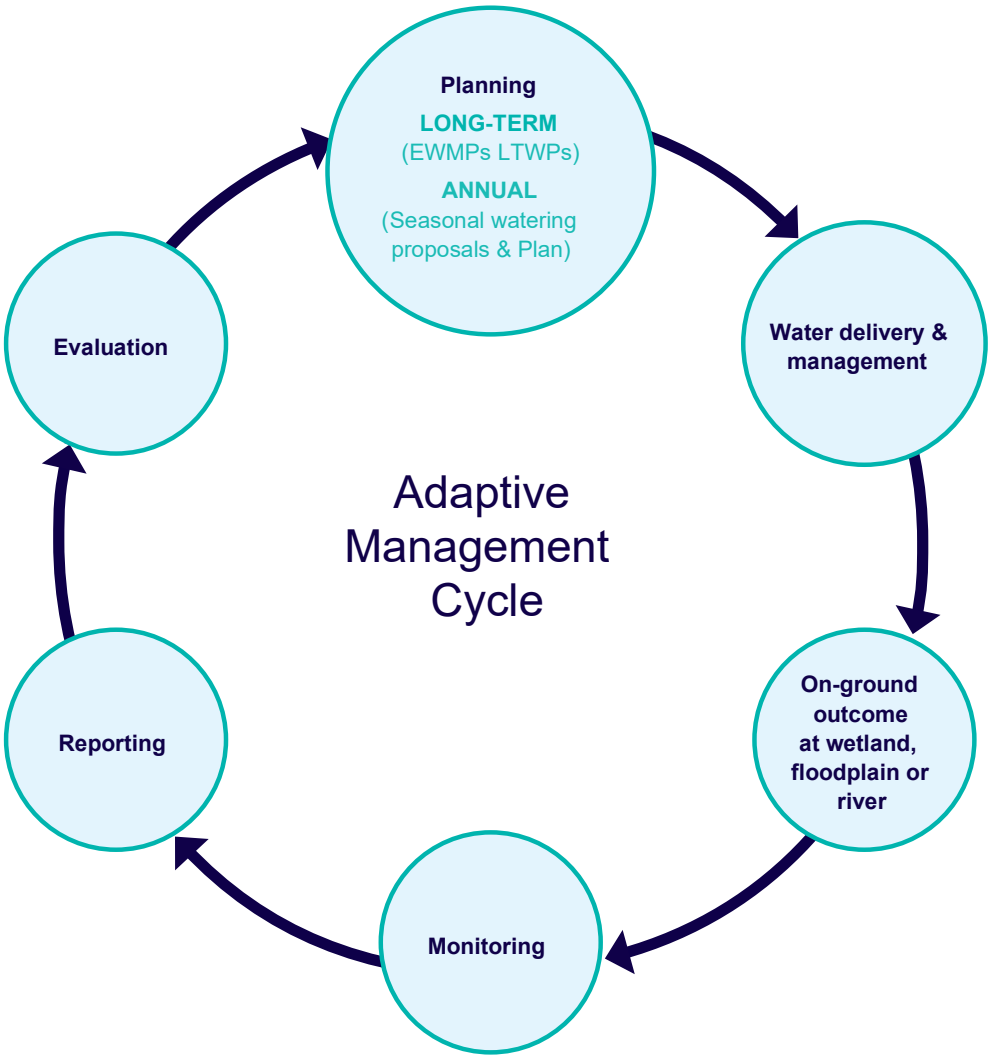


Figure 15: Adaptive Management Cycle

Specific policy and processes currently operate in Victoria that facilitate this cycle, for example the VWMS and Regional Waterway Strategies that guide regional prioritisation of waterways. Research projects also support this cycle by improving understanding of environmental flow outcomes, for example with development, review and updating of FLOWS studies for rivers (DEPI, 2013). FLOWS studies are a key information source in Victorian environmental water management, developed by expert scientists with input from CMAs, VEWH, DELWP and other key stakeholder and community representatives. Traditional Owners are also becoming increasingly involved in the development and update of FLOWS studies, an example of this was the recent update of the Lower Goulburn (Kaiela) Environmental Flows Study, where GBCMA engaged Yorta Yorta and Taungurung (Horne, et al., 2020). This collaborative work identifies the priority environmental values and objectives for each river system, and then uses the best available scientific knowledge to determine the specific water regime required to support these. This water regime information includes defining essential flow components for the suite of environmental objectives such as defining minimum and/or maximum flows to maintain water quality or geomorphology, and specifying the volumes, durations, seasonality and frequencies of other flow components such as fresh flows to trigger reproduction of valued species or other environmental events or cues. These assessments are used to help decide how much water needs to be recovered for the environment. Environmental flow studies using the FLOWS method have been completed for more than 50 rivers across Victoria. These technical inputs feed directly into development of the EWMPs and the planning step of the adaptive management cycle. For wetlands, a less proscribed process is followed as part of EWMP development itself, as the needed technical understanding of wetland water regime needs is not as developed as for rivers.

The water regimes in the EWMPs are used in seasonal watering proposals and so feed into seasonal watering plans, and then into on-ground management and delivery. Monitoring and evaluation assesses

whether the expected environmental outcomes are being achieved and the results and learnings (in particular from VEFMAP, WetMAP and TLM) are fed into decisions and management of the respective waterways. While EWMP flow recommendations form a basis for seasonal water plan development and flow delivery, not all flow regime components can be delivered all the time (e.g. due to constraints on bank full/overbank flows for rivers) or at the specified rates and duration. These recommendations must be managed within local constraints and HEW availability, and with local knowledge.

Results from monitoring at each site are communicated immediately after surveys to the CMAs' environmental water reserve managers. Managers then adjust their planning for the delivery of environmental water as necessary (e.g. see (Tonkin, 2020), in particular Figure 1.1.1, for more details). These learnings are then included when there are longer term adaptive updates to work such as FLOWS studies and EWMPs.

8.3 Monitoring of the long-term watering plan targets and objectives

Monitoring is important to evaluate whether environmental water is supporting the objectives and targets set in Section 3 of this plan. The development of the targets has drawn upon several research projects, designed to elucidate cause and effect relationships across Victoria. These projects are conducted by the ARI, Melbourne University, the Centre for Freshwater Ecosystems (formerly the Murray-Darling Freshwater Research Centre) and CSIRO Australia. Monitoring undertaken by CMAs also contributes; often this is undertaken to complement other monitoring and research projects (e.g. LTIM, Environmental Water Knowledge and Research (EWKR) projects). Outputs from these and other projects also provide data to assess progress to targets. The specific targets for environmental outcomes that were set to support this LTWP were originally set in 2015, and updated in 2017 (see Section 3.4 and Appendix D). Table 22 shows the monitoring programs and assets monitored to assess progress towards meeting these targets.

Two important caveats to Table 22 are:

- Not all current monitoring is considered adequate to assess progress towards targets, generally due to funding limitations.
- Targets will continue to be refined as more information is gathered.

For more information on both these caveats, see (Cooling, 2017). Iterative and adaptive management as described in Section 8.2 is ongoing to improve monitoring and target alignment.

Table 22: Objectives, targets and monitoring in the Northern Victoria water resource plan area (MDBFS = Murray-Darling Basin Fish Survey; NFRC = Native Fish Report Card; VEFMAP = Victorian Environmental Flows Monitoring and Assessment Program; WetMAP = Wetland Monitoring and Assessment Program)

Theme	Objective	Revised Target**	Recommended Assets	Current Monitoring
Fish	Improve abundance of large-bodied native fish.	A) The mean number of sites where large-bodied native fish species are detected is the same or higher in the last five years than the first five years of a ten-year monitoring program B) For age classes up to five years, the number of cohorts is the same or higher in the last year than the first year of a ten-year monitoring program	Birch's Creek; Campaspe River; Loddon River (mid, upper); Goulburn River; Broken River; Ovens River	VEFMAP MDBFS NFRC
	Maintain species richness of native fish	The ratio of fish species observed to expected (using pre-European Reference Condition - PERCH) is the same in the first three years as the last three years of a ten-year monitoring period	Birch's Creek; Coliban River	VEFMAP
Waterbirds	Improve habitat for waterbirds	The minimum water requirement for waterbird feeding and/or breeding is met in the ten-year period	Reedy Swamp; Doctors Swamp; Moodie Swamp; Lake Leaghur; Lake Meran; Lake Yando	WetMAP
Vegetation	Maintain the condition of aquatic vegetation in wetlands	The condition of wetland vegetation in the asset is better at the end than at the start of a ten-year monitoring period as measured by the following sub-targets: • cover/abundance of native species • native species richness • recruitment of woody and non-woody understorey and survival of juvenile plants	Lake Boort; Moodie Swamp; Lake Leaghur; Lake Yando; Lake Meran;	WetMAP VEFMAP
	Maintain the condition of river red gum dominated EVCs	The condition of river red gum dominated EVCs in the asset improves over ten years as measured by the following sub-targets: • health of adult river red gum trees • recruitment and survival of juvenile trees • native species richness • native species cover/abundance • recruitment of understorey vegetation	Campaspe River; Loddon River (mid, upper); Lake Leaghur; Lake Yando;	VEFMAP WetMAP

Theme	Objective	Revised Target**	Recommended Assets	Current Monitoring
Connectivity	Improve longitudinal connectivity (between river reaches and with the Murray)	The baseflow and fresh flow requirements as specified in each asset are met in eight years of a ten-year period	Campaspe River; Ovens River; Loddon River; Goulburn River	VEFMAP
Other values	Maintain species richness of frog communities	The number of frog species observed in eight in a ten years period must be more than 75% of the highest diversity recorded in any one year.	Reedy Swamp	WetMAP

** Note: Revisions were made to the 2014 LTWP targets by Ecological Associates (Cooling, 2017). See Appendix D

9. Long-term risks

This section describes the long-term risks associated with providing for the environmental watering requirements outlined in Section 3. These risks fall into two broad categories: failure to achieve (or demonstrate achievement of) ecological objectives and adverse impacts stemming from environmental water.

9.1 Processes for identifying risks

Environmental risk is commonly assessed as the product of the *likelihood* of a threat or threatening process occurring and the *consequence* in terms of the impact of a threat (or threats) on 'asset' values, condition or environmental outcomes. Victoria has a number of existing annual and longer-term processes in place for identifying and managing risks associated with environmental watering events, including:

- **Annual:** In the lead up to the development of the seasonal watering proposals each year, the VEWH coordinates annual shared risk identification and assessment workshops with CMAs across Victoria, held in mid-late February. The workshops are attended by relevant program partners such as environmental water holders, water corporations, Traditional Owners and public land managers. Partners jointly assess risks and commit to mitigation actions.
- **Long-term:** CMAs across Victoria, in collaboration with communities and partner agencies, identify key risks that may impact on the ability to achieve environmental watering objectives in preparing Environmental Water Management Plans (EWMPs) for priority environmental assets, and as part of water resource plans and Regional Waterway Strategies. These are documented in the CMA's EWMPs, along with risk management measures.

Both processes have been used to identify risks to include in this LTWP, considering the spatial and temporal scale of the plan.

9.2 Types of risks

The types of risks associated with providing environmental water requirements under this LTWP (see Section 3.5) fall into two broad categories:

- Failure to achieve the intended ecological objectives (or demonstrate their achievement).
- Adverse impacts in the provision of environmental water.

The risks associated with a failure to achieve the intended objectives are described in terms of the process by which they are generated and have been grouped into themes that reflect the consequence of the risk. The risks of adverse impacts arising from the provision of environmental water have been grouped by their impact on environmental, social and economic values. Management measures to address the risks identified in Figure 16 are presented in Appendix H. It should be noted that failure to provide sufficient water through the bulk entitlement process was addressed in Victoria's North and Murray Water Resource Plan (DELWP, 2020), as per Basin Plan clause 10.41).

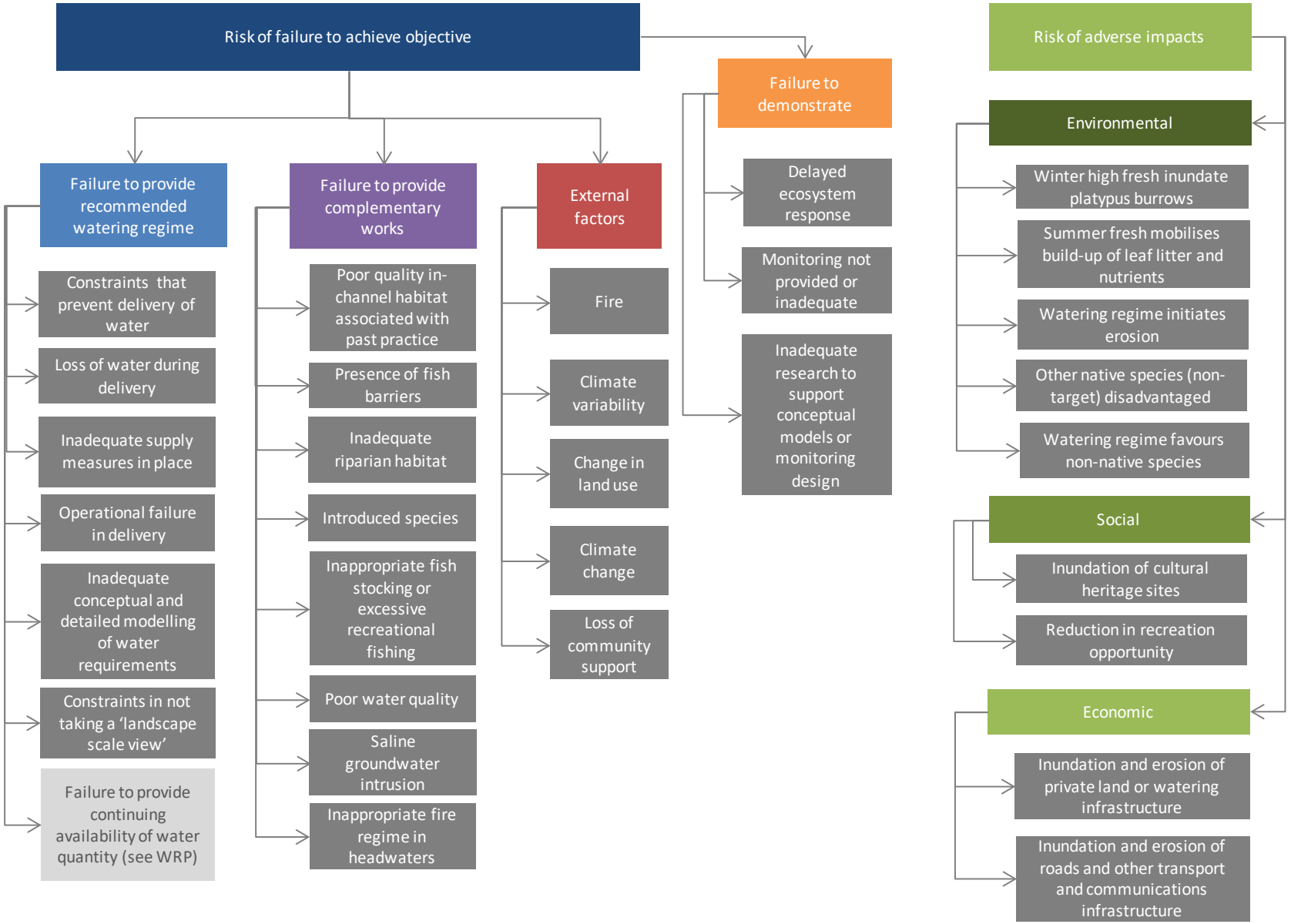


Figure 16: Risk types identified for this LTWP

9.3 Risk identification and assessment approach

While the characterisation of risk in Figure 16 and the management measures identified in Appendix H describe the suite of risks that may affect the benefits associated with environmental water management, they do not identify the relative importance of the risks or priorities for management. This has been addressed in Victoria's Northern and Murray Water Resource Plan (DELWP, 2020), which assigned levels of risk to events and their consequences in a manner consistent with AS/NZS ISO 31000:2009 Risk Management principles. This risk assessment was also undertaken in accordance with the provisions of the Basin Plan, which required that:

- Risks be examined in a consistent, structured and transparent way.
- Risk levels, ranging from very low to very high, be determined as a product of likelihood and the consequence of a risk occurring.
- Likelihood be assessed in terms of how each cause impacts on each threat, and consequence be assessed in terms of how each threat impacts on each beneficial use. The overall risk therefore represents how each cause will impact on each threat, and how that threat will in turn impact on each beneficial use.

The approach adopted in the Northern and Murray Water Resource Plan linked of causal factors, and their manifestation as threats, with limitations on the use and beneficial outcomes associated with the asset being considered (Figure 17). Threats were then ranked from very low to very high risk based on assessment rubrics of consequence and likelihood (Figure 18):

5 Very high risk.

4 High risk.

3 Medium risk.

2 Low risk.

1 Very low risk.

0 Not plausible.

The assessment of risks was considered on a water resource plan scale, rather than on a local scale, and was applied to the following risk categories (DELWP, 2020) (Table 23):

- Water availability.
- Structural form (i.e. in relation to longitudinal and/or lateral connectivity, instream physical habitat).
- Water condition.

It should be noted that this consideration of risk at the water resource plan scale is not intended to replace the site-specific risk assessments that are included in EWMPs or Seasonal Water Proposals.

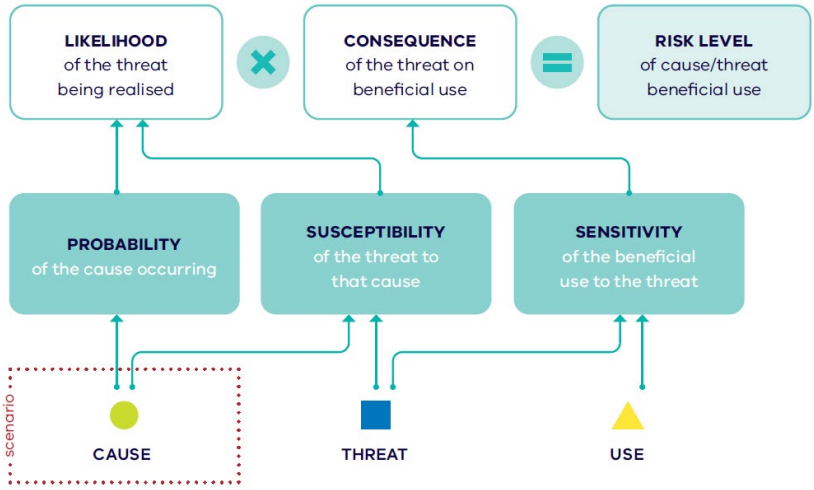


Figure 17: Overview of the risk assessment matrix, including cause-threat-use relationships for the Northern Victoria water resource plan area (from (DELWP, 2020))

Consequence (sensitivity of the beneficial use to the threat)	Likelihood (of the threat occuring)					
	Very high	*High*	*Moderate*	*Low*	*Very low*	*Not plausible*
Very high	Very high	Very high	High	Medium	Medium	Not plausible
High	Very high	High	Medium	Medium	Low	Not plausible
Moderate	High	Medium	Medium	Low	Very low	Not plausible
Low	Medium	Medium	Low	Very low	Very low	Not plausible
Very low	Medium	Low	Very low	Very low	Very low	Not plausible
Not plausible	Not plausible	Not plausible	Not plausible	Not plausible	Not plausible	Not plausible

Figure 18: Risk matrix comprising the combination of likelihood and consequence (Alluvium, 2016)

The high priority risks to address (i.e. causes and associated threats listed as 'very high' and 'high' risk to the environment in Table 23) include:

- Climate change.
- Extreme drought.
- Earth resource development.
- Changes to the timing and locations of demand.

Table 23: Northern Victoria water resource plan area summary of risks to priority environmental assets (DELWP, 2020). For risk levels, see legend below

Cause	Threat	Rivers	Wetlands
Climate change	Loss or decline in longitudinal connectivity		
	Loss or decline in lateral connectivity		
	Loss or decline in instream physical habitat		

Cause	Threat	Rivers	Wetlands
Extreme drought	Loss or decline in longitudinal connectivity		
	Loss or decline in lateral connectivity		
	Loss or decline in instream physical habitat		
Failure to continue to invest in best practice land use initiatives	Loss or decline in longitudinal connectivity		
	Loss or decline in lateral connectivity		
	Loss or decline in instream physical habitat		
Earth resource development	Loss or decline in longitudinal connectivity		
	Loss or decline in instream physical habitat		
Pests and weeds	Loss or decline in longitudinal connectivity		
	Loss or decline in instream physical habitat		
Changes to the timing and location of demands	Loss or decline in instream physical habitat		

Legend			
	Very high risk	High risk	Medium risk

9.4 Strategies for management

Management actions to address the high priority risks listed above are presented in Table 24. These actions also relate to issues discussed elsewhere in this LTWP (namely, the provision of environmental water (Section 4), constraints management (Section 6), complementary actions (Section 7) and demonstrating outcomes (Section 8)).

While risk management will initially focus on preventing or mitigating the effects of the high priority cause(s)/threats, a 'watching brief' will be kept on causes and threats with a medium (or lower) level of risk. This will allow scope for opportunistic management of medium level cause(s)/threats and prevent them from progressing to being high level risks. Action on medium level risks to environmental watering outcomes, such as the effects of pests and weeds, can also provide mutual benefits by addressing threats that are high level risks to consumptive user, recreational and Aboriginal outcomes. For example, investment in best practice land use initiatives could help mitigate excessive sediment and contaminants in runoff before it reaches waterways and consumptive water supplies.

Table 24: Summary of high priority environmental risks and related management measures (from (DELWP, 2020))

Risk level	Risk cause	Risk threat	Risk impact on beneficial uses	Confidence in risk assessment	Potential management actions
There is a very high risk	That climate change	Leads to a loss or decline in longitudinal connectivity	which results in adverse impacts on environment - rivers water uses/users.	This risk has a moderate level of confidence in its assessment.	• Deliver long-term watering plans • Environmental water management in a changing climate • Implement Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems • Improving our understanding of climate science and how it applies to water management • Improving public reporting on water availability and use: • user-focused information and reporting • Improving rural water supply planning • Improving state-wide water resource planning and risk assessment • Leading climate change adaptation across Victoria's water system • Managing groundwater related risks (including groundwater and surface water connectivity) through Victorian planning and implementation frameworks • Managing water quality events • Monitoring and reporting on the benefits of environmental watering • Planning the take of Victoria's Share Guidance - consideration of climate change and climate variability in setting groundwater resource limits • Protecting our waterways and their catchments by strengthening integrated catchment management across Victoria • Protecting water quality implementing the Environment Reference Standard (was
There is a high risk	That climate change	Leads to a loss or decline in longitudinal connectivity	Which results in adverse impacts on environment - wetlands water uses/users.	This risk has a moderate level of confidence in its assessment.	
There is a high risk	That climate change	Leads to a loss or decline in lateral connectivity	Which results in adverse impacts on environment - rivers water uses/users.	This risk has a moderate level of confidence in its assessment.	
There is a very high risk	That climate change	Leads to a loss or decline in lateral connectivity	which results in adverse impacts on environment - wetlands water uses/users.	This risk has a moderate level of confidence in its assessment.	
There is a very high risk	That climate change	Leads to a loss or decline in instream physical habitat	Which results in adverse impacts on environment - rivers water uses/users.	This risk has a moderate level of confidence in its assessment.	
There is a very high risk	That climate change	Leads to a loss or decline in instream physical habitat	Which results in adverse impacts on environment - wetlands water uses/users.	This risk has a moderate level of confidence in its assessment.	

Risk level	Risk cause	Risk threat	Risk impact on beneficial uses	Confidence in risk assessment	Potential management actions
					State Environment Protection Policy (Waters)) • Provide long-term investment to improve waterway health • Recognising and managing for Aboriginal values • Water resource information supports planning and decisions
There is a high risk	That extreme drought	leads to a loss or decline in longitudinal connectivity	Which results in adverse impacts on environment - rivers water uses/users.	This risk has a moderate level of confidence in its assessment.	• Deliver long-term watering plans • Improving our understanding of climate science and how it applies to water management • Improving public reporting on water availability and use: • user-focused information and reporting • Improving rural water supply planning • Improving state-wide water resource planning and risk assessment • Leading climate change adaptation across Victoria's water system • Managing groundwater related risks (including groundwater and surface water connectivity) through Victorian planning and implementation frameworks • Managing salinity, waterlogging and water quality including issues arising from an extreme wet period • Managing water quality events • Monitoring and reporting on the benefits of environmental watering • Preparing for and responding to extreme events (bushfire, failure to meet critical human water needs, blue-green algae blooms, flooding, major asset failure)
There is a high risk	That extreme drought	Leads to a loss or decline in lateral connectivity	Which results in adverse impacts on environment - wetlands water uses/users.	This risk has a moderate level of confidence in its assessment.	

Risk level	Risk cause	Risk threat	Risk impact on beneficial uses	Confidence in risk assessment	Potential management actions
					• Protecting our waterways and their catchments by strengthening integrated catchment management across Victoria • Protecting water quality/implementing the Environment Reference Standard (was State Environment Protection Policy (Waters)) • Provide long-term investment to improve waterway health • Recognising and managing for Aboriginal values • Water resource information supports planning and decision
There is a very high risk	That earth resources development	Leads to a loss or decline in instream physical habitat	Which results in adverse impacts on environment - rivers water uses/users.	This risk has a moderate-high level of confidence in its assessment.	• Managing risks from earth resources development • Protecting water quality implementing the Environment Reference Standard (was State Environment Protection Policy (Waters))
There is a very high risk	That earth resources development	Leads to a loss or decline in instream physical habitat	Which results in adverse impacts on environment - wetlands water uses/users.	This risk has a moderate-high level of confidence in its assessment.	
There is a very high risk	That changes to the timing and locations of demands	Leads to a loss or decline in instream physical habitat	Which results in adverse impacts on environment - rivers water uses/users.	This risk has a moderate level of confidence in its assessment.	• Deliver long-term watering plans • Environmental water management in a changing climate • Improving public reporting on water availability and use: • user-focused information and reporting • Maximising the effectiveness of the grid and markets across the state
There is a very high risk	That changes to the timing and locations of demands	Leads to a loss or decline in instream physical habitat	Which results in adverse impacts on environment - wetlands water uses/users.	This risk has a moderate level of confidence in its assessment.	

10. Consultation

Consultation during preparation of this long-term watering plan has involved environmental water holders and managers, river operators, local communities and those materially affected by the management of environmental water.

Consultation on the original 2015 LTWP is described below. The consultation carried out for the review and update of this LTWP over 2019-21 is described in Section 10.4.

In 2015, consultation on this LTWP occurred through a three-part devolved approach. It aimed to:

- *Involve* local communities, who have worked directly with CMAs to ensure information and concerns were understood and considered (10.1 below).
- *Collaborate* with the VEWH and CMAs, who have provided material and guidance for the LTWP (10.2 below).
- *Consult* with the water corporations, land managers, the MDBA, CEWH, upstream and downstream states, and MLDRIN, who provided information where relevant and feedback on the content (10.3 below).

10.1 Local engagement

During the development of the EWMPs that inform this LTWP, CMAs worked with local communities and stakeholders in order to gain input and feedback on all or a selection of the following: identification of the asset's ecological values; the long-term management goal for environmental watering of the asset; the ecological objectives for environmental watering; and the environmental watering requirements.

CMAs have a well-established network of stakeholders from local communities and peak bodies that are engaged on a range of issues. These networks are an effective mechanism to engage with local communities. In more recent years, as the environmental water portfolio has expanded, some CMAs have established specific environmental watering advisory groups (EWAGs).

Others have conducted engagement on as 'as-needs' basis. Examples of those involved include local landholders, Registered Aboriginal Parties, local Landcare or environment groups, interest groups (e.g. Field and Game, Birds Australia), local shires, local land managers, local representatives of water corporations and government agencies that manage relevant assets/infrastructure (such as roads, culverts, pipelines, and weirs), waterways and the environment, and representatives of CEWH and VEWH. Lists of those consulted can be found in individual EWMPs.

Examples of forums used in this tier include telephone interviews, site visits, workshops on water-dependent ecological values and review of the draft EWMP.

10.2 Working Group for the long-term watering plan

During the development of the original LTWPs in 2015, DELWP convened a working group to collaborate with key environmental water delivery partners. Members of the working group included the VEWH, Wimmera CMA, Mallee CMA, North Central CMA, Goulburn Broken CMA and North East CMA. Some of the working group members authored or coordinated the EWMPs relevant to this LTWP and gave priority environmental asset management and technical input to the LTWP. Advice and input were particularly sought on development of the environmental objectives and targets in this plan.

10.3 Stakeholder review

The working group, plus further key environmental water stakeholders provided input to the 2015 LTWP development through review of the draft plan. Victoria's draft LTWPs were released for comment on 1

September 2015. Drafts were provided to representatives from the VEWH, Wimmera CMA, North Central CMA, Mallee CMA, Grampians Wimmera-Mallee Water, Lower Murray Water and Parks Victoria. Drafts were also provided to the CEWH, MDBA, NSW and SA Environmental Water Working Group members and MLDRIN.

10.4 LTWP Review and Update

The MDBA has provided feedback on Victoria's 2015 LTWPs and have been consulted during preparation of this 2021 update. DELWP also commissioned a review of Victoria's LTWPs in 2019 (Peter Cottingham & Associates, Water's Edge Consulting, Hydro Geo Environmental Consulting, 2019). This update aims to address feedback from the MDBA and many recommendations from the 2019 review. Some recommendations will be addressed as part of the next update in 2023 (following the MDBA's update of the BWS).

As part of this update, DELWP held workshops with relevant CMA and VEWH staff during April-May 2021 and feedback on the draft was provided by these agencies. As described in Section 5.4, consultation on the LTWPs was carried out with Traditional Owner groups across northern Victoria during 2020.

11. Next Steps

This LTWP is one of many steps towards full implementation of Basin Plan. Monitoring and evaluation of the environmental objectives and targets is also required, to report on achievement of environmental outcomes at the asset scale (Basin Plan Matter 8). This requires continuation of relevant monitoring programs, as well as research and innovation programs aimed at better understanding of environmental flow needs of a river, wetland or landscape.

DELWP has recently updated EWMP guidelines to better align environmental objectives at the asset level with Basin Plan, to improve their adherence to SMART criteria and to guide partnership with Traditional Owner groups.

Further work will also be carried out to inform the next LTWP update, after the BWS is updated in 2023. This will progress knowledge and application of:

- Landscape scale (top down) approaches that can be integrated with the asset scale (bottom-up) approach taken in this LTWP iteration.
- Further asset-based technical work through development of EWMPs for new assets, EWMP reviews and EWMP updates where needed (in line with the revised EWMP guidelines). For example, updates to all Mallee EWMP environmental objectives were carried out in 2020 to improve their adherence to SMART criteria and alignment with Basin Plan.
- Use of the ANAE aquatic ecosystem classification V3 to refine the aquatic ecosystem types assigned to priority ecosystem assets.
- Further incorporation of Basin Plan principles and objectives in the VWMS renewal (due 2023).

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Appendix A Basin Plan obligation compliance

a) Basin Plan Chapter 8 (environmental watering plan) obligations

The table below presents the details of each of the Basin Plan obligations related to long-term watering plans and how each of these obligations has been addressed within this plan.

Table 25: Basin Plan obligation compliance

Topic	Basin Plan obligations	Clause	Relevant sections of LTWP
Identification of environmental watering requirements	A long-term watering plan must identify • priority environmental assets in the water resource plan area; and • ecological objectives and ecological targets for those assets; and • environmental watering requirements needed to meet those targets in order to achieve those objectives; • using the method in Section 8.49	8.19 (1)	Section 2.4 Sections 3.3, 3.4 Appendix E Appendix F
	• A long-term watering plan must identify • priority ecosystem functions in the water resource plan area; and • ecological objectives and ecological targets for those functions; and • environmental watering requirements needed to meet those targets in order to achieve those objectives; using the method in Section 8.50	8.19 (2)	Section 2.5 Sections 3.3, 3.4 Appendix E Appendix F
	If the Basin-wide environmental watering strategy has identified particular assets or functions, and their requirements under subparagraph 8.14(2)(a)(i), a long-term watering plan must be consistent with that part of the Basin-wide environmental watering strategy.	8.19 (3)	
Identification of possible co-operative arrangements	A long-term watering plan must identify: • possible co-operative arrangements (for example, possible co-operative watering regimes) between holders of held environmental water, managers of planned environmental water, and owners or managers of environmental assets for the delivery of environmental water: • within the water resource plan area; and • between that area and upstream and downstream water resource plan areas; that will ensure that environmental water meets the environmental watering requirements identified above.	8.19 (4)	Section 5

Topic	Basin Plan obligations	Clause	Relevant sections of LTWP
Identification of long-term risks	A long-term watering plan must identify: • long-term risks to providing for the environmental watering requirements of priority environmental assets and priority ecosystem functions; and • the strategies to manage those risks having regard to the strategies in Chapter 4[8].	8.19 (5)	Section 9
Operational constraints	A long-term watering plan must: (a) identify any operational constraints in relation to environmental watering in the water resource plan area; and (b) include strategies to manage or overcome those constraints.	8.19 (6)	Section 6
Supporting Information	A long-term watering plan must include references to the information that informed its preparation.	8.19 (7)	Throughout & References Section
Consultation.	A Basin State must prepare a long-term watering plan in consultation with: • holders of held environmental water; and • managers of planned environmental water; and • river operators; and • local communities, including bodies established by a Basin State that express community views in relation to environmental watering; and • persons materially affected by the management of environmental water. Note: Under paragraphs (a) and (b), a Basin State may consult with any holder or manager whose environmental water could contribute to environmental watering in the water resource plan area, regardless of the location of the holder or manager, or of the location of the water.	8.20 (1)	Section 10
Matters to which Basin State is to have regard	When preparing a long-term watering plan, a Basin State must have regard to the Basin-wide environmental watering strategy (Division 2). A long-term watering plan must be developed consistently with the principles to be applied in environmental watering (Division 6).	8.20 (2)	Sections 2-3 Appendix E Throughout See Table 26
Consistency with international agreements	A long-term watering plan must not be inconsistent with relevant international agreements.	8.20 (5)	Section 2

[8] Strategies listed in Chapter 4 of Basin Plan: (1) the environmental watering plan; (2) water quality and salinity management plan; (3) water trading rules; (4) water resources planning

b) Basin Plan environmental watering plan Division 6 principles

The table below presents the details of each of the Division 6 principles of the environmental water plan (Chapter 8 of Basin Plan) and where they are addressed in this LTWP or elsewhere.

Table 26: Basin Plan Environmental Watering Plan Division 6 Principles

Principle	Where addressed in LTWP or elsewhere	Comment
Principle 1—Basin annual environmental watering priorities Environmental watering is to be undertaken having regard to the Basin annual environmental watering priorities. Note: There may be reasons why it is not possible in particular circumstances to undertake watering in accordance with these priorities. Section 8.44 then applies.	Annual watering priorities are established via seasonal watering proposals for individual assets, which in turn are prioritised through the annual VEWH Seasonal Watering Plan (see Sections 1.6.4 to 1.6.6).	Basin annual watering priorities are increasingly a consideration for asset managers when planning environmental water delivery to individual assets in accordance with EWMPs.
Principle 2—Consistency with the objectives in Part 2 Environmental watering is to be undertaken consistently with the objectives in Part 2.	Ecological objectives for Northern Victoria assets, including their alignment with Basin Plan Chapter 8 objectives, are presented in Section 3.3.	The 3 overarching Basin Plan Objectives are: (a) to protect and restore water-dependent ecosystems of the Murray-Darling Basin; and (b) to protect and restore the ecosystem functions of water-dependent ecosystems; and (c) to ensure that water-dependent ecosystems are resilient to climate change and other risks and threats.
Principle 3—Maximising environmental benefits Subject to the principles in Sections 8.33 and 8.34, environmental watering is to be undertaken in a way that: (b) maximises its benefits and effectiveness by: (i) co-ordinating environmental watering between all holders of held environmental water and managers of planned environmental water; and (ii) co-ordinating environmental watering with flows regulated for consumptive use; and (iii) utilising local knowledge and experience; and (iv) having regard to Indigenous values; and (v) having regard to social and economic outcomes; and	Described in detail as part of the environmental watering framework (see Section 1.6.2). Opportunities to achieve shared benefits from environmental watering will be considered, including contributions to social, cultural, recreational and economic benefits. However, the use of environmental water to provide shared benefits cannot be prioritised at the expense of achieving environmental objectives (see Section 1.6.7). See also the response to Principles 10 and 11 (below).	Other environmental water co-ordination mechanisms to which DELWP is a party includes: • Southern Connected Basin Environmental Water Committee (SCBEWC) • Environmental Water Improvement Group (EWIG).

Principle	Where addressed in LTWP or elsewhere	Comment
(c) enhances existing flow events, where possible, so as to ensure improvement in the delivery of a full range of flow conditions, including high flow events; and	Annual watering priorities are established via seasonal watering proposals for individual assets, which in turn are prioritised through the annual VEWH Seasonal Watering Plan (see Section 1.6.4and 1.6.5 Delivery of a full range of flow conditions can require cooperative arrangements in the delivery of both environmental and consumptive water. Cooperative arrangements between water delivery partners are presented in Section 5.	Other environmental water co-ordination mechanisms to which DELWP is a party includes: • Southern Connected Basin Environmental Water Committee (SCBEWC) • Environmental Water Improvement Group (EWIG).
(d) takes into consideration the relative ecological benefits of applying environmental water to achieve one environmental outcome over another environmental outcome; and	See Principle 3c (above).	
(e) takes into consideration the variability of the natural flow regime, for example, by mitigating or avoiding seasonal inversion of flows; and	Addressed in EWMPs and Environmental watering plans for individual assets (see Section 3 and Appendix F).	
(f) incorporates strategies to deal with a variable and changing climate; and	Addressed in the Long-term Risk section (Section 9).	Risk characterisation and management actions have been aligned to that presented in the Northern Victoria Water Resource Plan.
(g) enables information to be shared between the Authority, the Commonwealth, Basin States, holders of held environmental water and managers of planned environmental water to ensure efficient and effective use of environmental water.	Victoria's two main environmental water monitoring programs, the Victorian Environmental Flows Monitoring and Assessment Program, and the Wetland Monitoring and Assessment Program for environmental water. Both programs include monitoring that relates to the objectives and targets outlined in Victoria's long-term watering plans, which have direct links to objectives outlined in the EWMPs, as well as the objectives listed in both the Basin-wide environmental water strategy and in the Murray-Darling Basin Plan in Chapters 5 and 8, Schedules 7 and 8 (see Section 8.1).	These, and programs such as the Long-term Intervention Monitoring program, contribute to Victoria's Schedule 12 Matter 8 reporting.
Principle 4—Risks Environmental watering is to be undertaken having regard to: (a) potential risks, including downstream risks, that may result from applying environmental water and measures that may be taken to minimise the risks; and (b) risks arising from impediments to the delivery of water to water-dependent ecosystems, including risks of extraction of that water for other uses, and inadequate accounting of water flows.	Addressed in the Long-term Risk section (Section 9).	Risk characterisation and management actions have been aligned to that presented in the Northern Victoria Water Resource Plan.

Principle	Where addressed in LTWP or elsewhere	Comment
Principle 5—Cost of environmental watering Environmental watering is to be undertaken having regard to the quantity of water and other resources required relative to the expected environmental benefits.	Addressed in the VEWH seasonal watering plan and its criteria for prioritising environmental watering actions.	Likely environmental benefits compared against: • Cost to deliver and manage water • Costs of interventions to manage external threats and risks
Principle 6—Apply the precautionary principle A lack of full scientific certainty as to whether there are threats of serious or irreversible environmental damage should not be used as a reason for postponing measures to prevent environmental degradation.	This principle is dealt with in Victoria's Waterway Management Strategy (DEPI 2013b), in addressing Principle 3g (sharing of information) and Principle 4 (assessment and management of risks) (above). It is also addressed in Principle 8 (adaptive management) and Principle 9 (international agreements) (below).	
Principle 7—Working effectively with local communities Environmental watering should be undertaken having regard to the views of: (a) local communities, including bodies established by a Basin State that express community views in relation to environmental watering; and (b) persons materially affected by the management of environmental water.	Community engagement, including with First Nations and other Aboriginal parties, is addressed in Section 10.1(local engagement) and 10.3(stakeholder review).	
Principle 8—Adaptive management Adaptive management should be applied in the planning, prioritisation and use of environmental water.	Addressed in the Improving Outcomes (see Section 8.2).	
Principle 9—Relevant international agreements Environmental watering should be undertaken in a way that is not inconsistent with relevant international agreements. Note: A purpose of the Basin Plan, including Chapter 8, is to give effect to relevant international agreements (see paragraph 20(a) and subsections 21(1), (2) and (3) of the Act). This provision is a further check to ensure that this purpose is achieved.	A management goal for the LTWP is to 'Maintain or improve wetlands of International, National or State significance' (see Section 3.2). International agreements are considered further as Ramsar-listed wetlands are included as priority environmental assets (see Section 2.5)	

Principle	Where addressed in LTWP or elsewhere	Comment
Principle 10—Other management and operational practices River management and operational practices should be reviewed, and if necessary altered, to ensure that rivers can be managed to achieve multiple objectives, including the objectives in Part 2.	Under the *Water Act 1989* (Vic),held environmental water is managed as part of Bulk Entitlements, which specify the water available to users, including consumptive users and the environment (see Section 1.4). Water management to achieve multiple outcomes are also included in the Victorian Waterway Management Strategy (DEPI 2013b) and the Regional Catchment Strategies and Regional Waterway Strategies of the relevant CMAs. Increasingly, the delivery of consumptive and environmental water is being managed in a cooperative manner through such forums as the Southern Connected Basin Environmental Water Committee (SCBEWC), the Environmental Water Improvement Group (EWIG) and the Water Liaison Working Group (WLWG) - Victoria is party to each group.	
Principle 11—Management of water for consumptive use Management of water for consumptive use should, where possible, be undertaken in a way that is consistent with achieving the objectives in Part 2.	See Principle 10 (above).	

c) Ecological Assets and Functions Database Themes

Table 27: Ecological Assets and Functions Database Themes used in this LTWP

Theme	Matter 9 Theme ID
End of Basin Flows	1.3
Ecosystem processes (e.g. carbon and nutrient cycling)	6
Fish	4
Geomorphology (maintenance of)	1.4
Longitudinal connectivity	1.1
Lateral connectivity	1.2
Macroinvertebrates	7
Other fauna related	7
Other (e.g. resilience, ecosystem diversity, …)	7
Vegetation related	2
Wetland related	7
Waterbirds related	3
Water quality (Physico-chemical)	5

Appendix B Environmental Water Management Plans

Environmental Water Management Plans (EWMPs) are developed to capture the long-term environmental watering requirements of priority Victorian wetlands and rivers that

- Have environmental values at risk from altered water regimes, and
- Can receive environmental water (DEPI, 2013 - VWMS).

EWMPs have been completed across Victoria. EWMPs provide information to assist development of the Victorian Environmental Water Holder's (VEWH) Seasonal Watering Plan, as well as the Annual Watering Priorities and long-term watering plans for the Basin Plan.

An EWMP is a scientifically based management plan that documents:

- The natural versus developed hydrology of the site, indicating what changes have occurred, leading to why environmental water is needed
- Priority environmental values (those that rely on flows or inundation for all or part of their life cycle) associated with the wetland or river
- The condition of the wetland or river and its environmental values, indicating why the wetland or river requires environmental watering action
- An overarching environmental water management goal for the wetland or river, relating to the important ecological values, that can be advanced through environmental watering
- Long-term ecological objectives that help meet the management goal
- The watering requirements for each objective
- A watering regime that considers all watering requirements needed to meet the objectives
- Constraints to watering at the site
- Risks to meeting the objectives
- Monitoring required to demonstrate whether the objectives have been met
- Outcomes of community consultation that has occurred during development of the EWMP.

The watering requirements to meet the ecological objectives are based on established technical information including FLOWS studies (for Victorian rivers). The expected ecological benefits of managed watering and drying (Alluvium, 2016) underpin the watering requirements of the EWMP.

The use of expert advice in developing the hydrological regime is an important component to the development of EWMPs. Where known, the hydrological tolerances of the ecological objectives are included to help establish thresholds for watering/not watering.

The EWMP process, as undertaken by CMAs with external expert advice, assists in creating a robust and scientifically defendable management plan, which effectively identifies a plan to best manage environmental watering at designated sites.

Also important to the EWMP is input from community and from Traditional Owners, regarding the ecological values present at a wetland or river reach ('the asset'), the management goal for the asset, the objectives, and the hydrological regime of the asset. The involvement of Traditional Owners has increased over recent years and as of 2021 the protocol is for them to be partners in EWMP development.

EWMPs from the Wimmera, Mallee, North Central, Goulburn Broken, and North East CMAs have been used as important input to the preparation of LTWPs for Victoria's Basin Plan requirements. In particular, EWMPs have been used in the development of LTWP ecological objectives and watering requirements.

EWMPs also provide important asset-based information for other LTWP requirements regarding constraints, risks and community consultation.

All Victorian Basin Plan EWMPs are available at https://www.water.vic.gov.au/waterways-and-catchments/rivers-estuaries-and-waterways/environmental-water/environmental-water-management-plans.

The table below lists the EWMPs for priority environmental assets in the Northern Victoria water resource plan area where further details can be found on all aspects of management of environmental watering.

Table 28: EWMPs for priority environmental assets in the Northern Victoria water resource plan area

Asset Name	CMA	EWMP (or other document)
Birch's (Bullarook) Creek	NCCMA	Birch's (Bullarook) Creek EWMP
Broken River	GBCMA	Broken River EWMP
Buffalo River	NECMA	Ovens River – Buffalo River EWMP
Campaspe River	NCCMA	Campaspe River EWMP
Coliban River	NCCMA	Coliban River EWMP
Doctors Swamp	GBCMA	Doctors Swamp EWMP
Gaynor Swamp	GBCMA	Gaynor Swamp EWMP
Goulburn River	GBCMA	Goulburn River EWMP
Horseshoe Lagoon[1]	GBCMA	Horseshoe Lagoon EWMP
Kanyapella Basin[1]	GBCMA	Kanyapella Basin EWMP
King River	NECMA	Ovens River – King River EWMP
Lake Boort	NCCMA	Lake Boort EWMP
Lake Leaghur	NCCMA	Lake Leaghur EWMP
Lake Yando	NCCMA	Lake Yando EWMP
Loch Garry[1]	GBCMA	Loch Garry EWMP
Loddon River (Middle and Upper)	NCCMA	Loddon River EWMP
Meran Lakes complex (Lake Meran and Little Lake Meran)	NCCMA	Meran Lakes EWMP
Moodies Swamp	GBCMA	Moodies Swamp EWMP
Mullinmur Wetland[1]	NECMA	EWMP due 2022
Ovens River	NECMA	Ovens River EWMP
Pyramid Creek[1]	NCCMA	Loddon River EWMP – Pyramid Creek
Reedy Swamp	GBCMA	Reedy Swamp EWMP
Round Lake[1]	NCCMA	Round Lake EWMP
Serpentine Creek[1]	NCCMA	Loddon River EWMP – Serpentine Creek
Tullaroop Creek[1]	NCCMA	Loddon River EWMP – Tullaroop Creek
Twelve Mile Creek[1]	NCCMA	Loddon River EWMP – Twelve Mile Creek
Upper Broken Creek[1]	GBCMA	Upper Broken Creek Environmental Flows Study

[1]*These sites are now watered regularly and being considered for full inclusion as priority environmental assets in the next LTWP update following the next BWS update planned in 2023.*

Appendix C Determining objectives, targets and watering requirements

This appendix describes the approach used to develop ecological objectives and targets for the Northern Victoria water resource plan area and this LTWP. The overall process is shown in Figure 19 below and is described in the following section. The green processes and products relate to objectives while the blue relates to targets, and the orange relates to watering requirements.

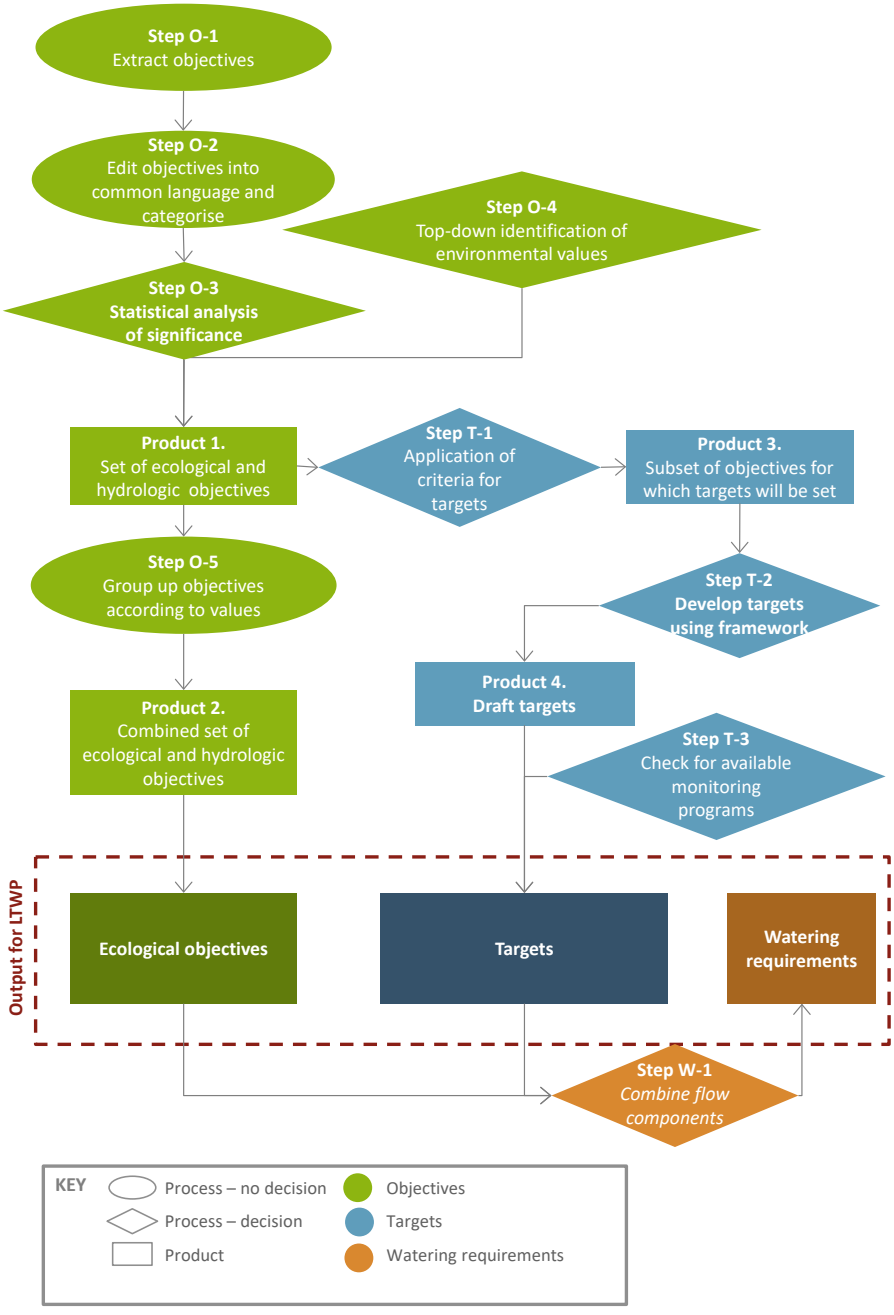

Figure 19: Overview of process for developing objectives and targets

The first step in process was to collate all available ecological objectives for environmental watering sites (assets) and ecological functions, as documented by Victoria's CMAs in Regional Waterway Strategies, EWMPs, SDL Business cases and TLM ecological watering guides. In all, for the three water resource plan areas, 70 individual plans were identified that covered over 100 assets. Some 600 individual objectives were identified within the 70 plans.

Step O-2

The list of extracted objectives contained a wide variety of terminology and level of detail. The next step in the process was to standardise each objective into a consistent suite of language and detail. Each objective was categorised according to Figure 20.

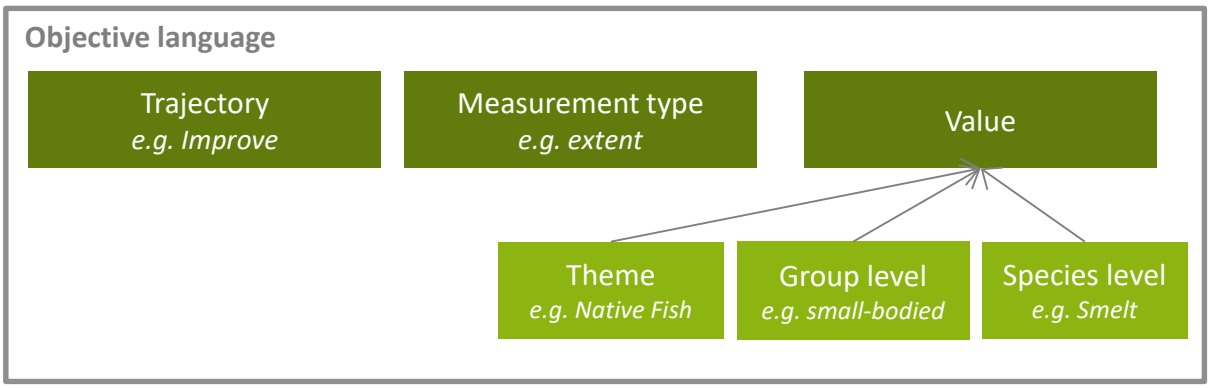

Figure 20: Objective language used to standardise objectives and categorise them

The **trajectory** represents the intended change (improve, maintain and reduce). The **measurement type** identifies in which particular aspect of the value the change should occur. This could include extent, abundance, species richness, condition, breeding, etc.

The **value** is the part of the ecosystem that is of interest, and split into 3 increasing levels of detail:

- Theme (native fish, vegetation, waterbirds, river flows and connectivity, other)
- Group-level (e.g. small-bodied fish, river red gum communities, colonial-nesting waterbirds)
- Species-level (e.g. brolga, Murray hardyhead, Charophytes)

Some objectives included cross-theme components, or included many group level elements. These were split into separate themes or groups. For example, the following objective was split between the vegetation and the waterbird theme:

"*To provide a watering regime that supports a Cane-grass/Plains Grassy Wetland Complex and provides breeding opportunities for a diverse range of native wetland biota in particular brolga*"

Examples of the final list of objectives included:

- Improve abundance of short lived/ small-bodied fish.
- Maintain condition of river red gum communities.
- Improve feeding areas for waterbirds.

Step O-3

To achieve a set of objectives that are relevant at a regional scale (i.e. the water resource plan area scale), objectives were ranked within each water resource plan area based on the number of assets that had an objective related to each value (group level) measurement type and trajectory. This is the **bottom-up approach** to achieving a set of objectives that represent the region.

Note:

The production of a set of objectives for each water resource plan area in no way diminishes the importance of objectives at an individual asset scale. Some objectives that occur at only a few assets are not included in the Regional Objectives, but still remain valid for watering of the assets with that objective. Similarly, where the Regional Objective trajectory is "Maintain", and a particular asset trajectory is "Improve", any watering plan at the asset level should still be designed to improve the value.

It is recognised that there are no formal criteria for selecting how many assets need to have a particular value, measurement type or trajectory for inclusion, so there is a degree of subjectivity in the development of a regional set of objectives.

Step O-4

The sets of objectives were then cross-checked for gaps based on subjective assessments of the values in each water resource plan area. This subjective process was informed by guidance from the VEWH and DELWP, and expert ecologists (Alluvium team, Jane Roberts and Terry Hillman - LTWP reviewers).

This is the **top-down approach** at a regional scale to complement the bottom-up approach drawn from the objectives at an asset scale.

One identified objective that is not covered by individual asset objectives relates to the maintenance or improvement of the suite of wetland types (number and type based on water regime) across each water resource plan area.

Based on steps O-3 and O-4, a set of objectives was developed (in the format described in Step O-2). This feeds into the target setting process (from Step T-1).

Step O-5

To give the objectives more meaning and enhance readability, they were grouped according to the value (group level) they were focused on.

For example, where the following three objectives were included in the set of objectives (Product 1), they could be grouped into one objective about river red gum communities (the value).

Improve condition of river red gum communities

+

Maintain extent of river red gum communities

+

Improve species richness of river red gum communities

=

Maintain extent and improve species richness and condition of river red gum communities

Based on this grouping process, a set of objectives was selected for each water resource plan area. This feeds directly into the LTWP.

Step T-1

Not all of the objectives will lead to good targets that can be used for reporting outcomes. Therefore, targets will be set for a subset of the objectives. This subset of objectives needs to be based on criteria for target setting. The subset of objectives should lead to targets being set that meet these criteria and also be significant to the water resource plan area. Therefore, the following criteria were adopted (Figure 21)

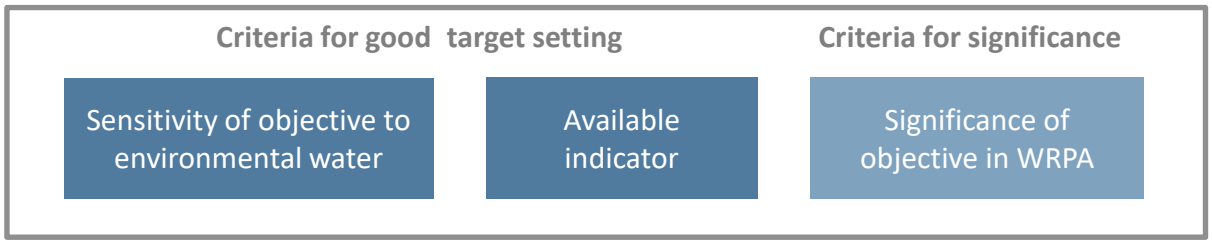

Figure 21: Criteria for target setting

The **sensitivity of the objective to environmental water** includes whether water delivery is the critical component that would lead to achieving the objective, or how dependent the value or asset associated with the objective is on water delivery. For example, successful bird breeding events are highly sensitive to flow duration, and are therefore sensitive to the delivery of environmental water. Conversely, there is not a strong link established between flow and species richness of macroinvertebrates.

In order to match a target against an objective and report on that target, there must be an **available indicator** that can be monitored. This indicator guides the target setting process and relates directly to the *measurement type* component of the objective. For example, for extent of vegetation an indicator could be area in hectares. Some objectives where it would be difficult to provide an indicator include:

Maintain the quality of geomorphic habitat.

Improve breeding opportunities for platypus and rakali communities

Given that only a subset of the objectives for each water resource plan area will have targets set, this subset should represent the most **significant objectives** for that region. This significance has been informed by the number of assets in the water resource plan area that relate to each objective and also expert opinion. Note this is similar to the process used for the objectives in steps O-3 and O-4.

Based on the described criteria, a subset of objectives was selected for each water resource plan area to be used in the remainder of the target setting process.

Step T-2

In order to compose the targets, the following framework was used. This framework is based on the principles for target setting in the LTWP and an understanding of what components are required to set good targets that can be monitored and used for reporting.

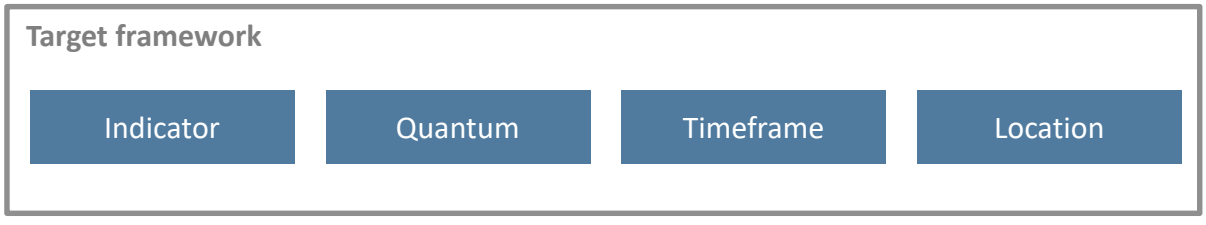

Figure 22: Framework for developing targets

The **indicator** was identified in Step T-1 (criteria for targets) and is the metric, that is, the item that will be measured. It relates directly to the objective type and value. For example, the **area** of Red Gum communities or **count per unit effort** (CPUE) of fish.

The **quantum** relates to the amount of the indicator that should be achieved. For example 3,000 ha or 10% increase. A target will include a **timeframe** within which the target should be achieved. Examples could include within 5 years or occurs in 90% of years. The **location** considers at which assets or type of assets the target should be achieved, for example, Tang Tang Swamp or priority river reaches.

For the subset of objectives (Product 3), draft targets were developed based on the framework for target setting. Any of these targets could be appropriate for inclusion in the LTWP.

Step T-3

Based on the draft targets, an extensive monitoring program would be required to report on every target. Given that limited resources are available for monitoring, DELWP has indicated a preference to use existing monitoring programs where possible. Therefore the list of draft targets was filtered for targets where there is an existing monitoring program already in place and/or can be replicated at increased spatial or temporal scales. This also impacts on whether baseline data will be available.

The output of step T-3 will be a finalised list of targets that will be incorporated into the LTWP.

Step W-1

The final step is to determine the watering requirements. At the regional scale, this is done by linking the objectives and targets to the relevant flow components. The EWMPs and Seasonal Watering Plan (SWP), which is developed each year, provide further detail on the watering requirements at an asset scale.

Appendix D Updates to LTWP targets

Updates to the LTWP targets were made by Ecological Associates (Cooling, 2017) during the process of developing the monitoring and evaluation plan to measure progress towards achievement of the objectives.

The targets were amended to ensure that they were measurable, unambiguous, time-bound and set clear thresholds for success. Where possible, the targets were worded to more closely align with existing monitoring protocols. This appendix presents the original target wording from the LTWP and the rationale for the amended wording.

Further modifications and improvements to these targets are planned.

Fish Target 1

Fish Target 1 has two parts A and B.

Part A addresses the LTWP objective to "Improve abundance of large-bodied native fish". The target in the 2014 LTWP is:

Increase the spatial distribution of large-bodied native fish over a ten year period to 2025.

There are some points to clarify in the wording of this target.

- The target is evaluated by monitoring particular large-bodied species which are specified in the asset plans.
- Each species will be reported on, requiring sub-targets in several assets.
- To measure an increase in spatial distribution it is necessary to monitor sites where the fish are not present but are expected to occur in the future.
- The target does not specify a baseline from which the increase will measured. Taking a single year as a baseline, such as 2015 can be problematic if it is not representative. Taking baseline data from other studies may not be comparable if the sampling effort is different.

The following amended wording was adopted.

The mean annual number of sites where large-bodied native fish species are detected is higher in the last five years than the first five years of a ten year monitoring program.

Part B addresses the LTWP objective to "Improve abundance of large-bodied native fish". The target in the LTWP is:

Increase size and/or age distribution of large-bodied native fish over a ten year period to 2025.

There are some points to clarify in the wording of this target:

- The target is evaluated by monitoring particular large-bodied species which are specified in the asset plans.
- Each species will be reported on, requiring subtargets in several assets.
- It is unclear what is meant by an 'increase' in size/or age distribution. It is expected that it refers a more even distribution of age classes across the population which indicates frequent recruitment and good survival.
- It is unclear how the target relates to the objective. Size distribution is likely to reflect mortality factors, including fishing pressure.
- The target allows either age or size to be measured which could create problems for consistency in data collection.
- The data will be in the form of frequency distributions which could be differentiated statistically or by expert interpretation.

- If data is collected from several sites within an asset (sub-populations), pooled data will not provide an accurate representation of the asset population. Instead each sub-population should be reported separately or a single representative site should be sampled.
- The target does not specify a baseline from which the increase will measured. Taking a single year as a baseline, such as 2015 can be problematic if it is not representative. Taking baseline data from other studies may not be comparable if they used different methods.

The following amended wording was adopted:

> *For annual age classes up to five years, the number of cohorts is the same or higher in the last year than the first year of a ten year monitoring program.*

Fish Target 2

Fish Target 2 addresses the LTWP objective to "Maintain species richness of native fish". The target in the LTWP is:

> *Maintain species richness of native fish in 80% of years between 2015 and 2025.*

There are some points to clarify in the wording of this target:

- The target does not specify how the baseline fish diversity is defined. This could be the number of species observed in the first year of sampling using a specific method. A difficulty is that this may not be a representative year to observe fish. Alternatively the baseline could be the number of species observed over several years preceding 2015 from a range of sources. A difficulty with this approach is it could include more species than a single standardised method could detect.
- It would be less ambiguous to say that the number of species must not be less than the threshold of eight of the ten years to 2025.
- The number of species will increase with survey effort. It is important to use a consistent method.

The following amended wording was adopted:

The ratio of fish species observed to expected (using the pre-European Reference Condition - PERCH) is the same in the first three years as the last three years of a ten year monitoring period.

Waterbirds Target 1

Waterbirds Target 1 addresses the LTWP objective to "Improve breeding opportunities for waterbirds" in the Wimmera Mallee WRPA. The target is:

> *Deliver water, if and as required, to complement natural flood events to complete breeding events in 1 out of 20 years.*

This target relates to Lake Hindmarsh and Lake Albacutya.

There are difficulties with the wording of this target:

- The target involves a management response to natural flood in Lakes Hindmarsh and Albacutya that occur with a frequency of 1 in 20 years. These events occur stochastically, and over the long term they may be separated by intervals of several decades. It is impossible to evaluate this target within the 10 year lifespan of the LTWP.
- For the target to be met, the delivered water must result in waterbirds completing their breeding. However, it is impossible to know if breeding would have failed without the delivered water.

The following amended wording was adopted:

> *Deliver water to support waterbird breeding events in Lakes Hindmarsh and Albacutya.*

Vegetation Target 1

Vegetation Target 1 addresses the LTWP objective to "Improve condition of riparian EVCs". The target is:

> *Increase distribution, [species] richness and abundance of riparian vegetation in riparian EVCs.*

There are some points to clarify in the wording of this target:

- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- An increase in the extent of the EVC is not necessarily desirable if it comes at the expense of other vegetation types.
- Measuring an increase in extent involves measuring areas where the vegetation is not currently present.
- The meaning of 'abundance' is not clear but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be 2015.
- The target does not specify when the thresholds must be achieved, but it is expected to be 2025.

An alternative target wording is proposed based on the vegetation condition monitoring developed in VEFMAP:

> *The condition of riparian EVCs in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets:*
>
> - health of adult trees
> - recruitment and survival of juvenile trees
> - native species richness
> - native species cover/abundance
> - recruitment of understorey vegetation.

Vegetation Target 2

Vegetation Target 2 addresses the LTWP objective to "Maintain condition of aquatic vegetation in wetlands" in the Northern Victoria WRPA. The target is:

> *The 2009-2011 IWC biota score maintained at priority wetland assets in 2025.*

There are some points to clarify in the wording of this target:

- It is not clear why assets are specified as 'priority'.
- The IWC biota score incorporates a number of broad indicators. It is likely to be too insensitive to detect vegetation responses to water management within the timeframe of the LTWP.
- 2009-2011 biota scores are not available for all the assets.
- It is recommended that the condition of aquatic vegetation is measured directly using protocols set out in WetMAP.

An alternative target wording is proposed based on the vegetation condition monitoring developed in WetMAP:

> *The condition of wetland vegetation in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets:*
>
> - cover/abundance of native species
> - native species richness
> - recruitment of woody and non-woody understorey and survival of juvenile plants.

Vegetation Target 3

Vegetation Target 3 addresses the LTWP objective to "Maintain condition of river red gum dominated EVCs" in the Northern Victoria WRPA. The target is:

> *Maintain distribution, [species] richness and abundance of riparian vegetation in river red gum dominated EVCs.*

There are some points to clarify in the wording of this target:

- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- An increase in the extent of the EVC is not necessarily desirable if it comes at the expense of other vegetation types.
- Measuring an increase in extent involves measuring areas where the vegetation is not currently present.
- The meaning of 'abundance' is not clear, but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be 2015.
- The target does not specify when the thresholds must be achieved, but it is expected to be 2025.

An alternative target wording is proposed based on the vegetation condition monitoring developed in VEFMAP:

> *The condition of River Red Gum dominated EVCs in the asset improves over ten years as measured by the following sub-targets:*
>
> - health of adult River Red Gum trees
> - recruitment and survival of juvenile trees
> - native species richness
> - native species cover/abundance
> - recruitment of understorey vegetation.

Vegetation Target 4A

Vegetation Target 4A addresses the LTWP objective to "Improve condition of River Red Gum dominated EVCs" in the Northern Victorian WRPA. The target is:

Increase distribution, [species] richness and abundance of riparian vegetation in River Red Gum dominated EVCs.

There are some points to clarify in the wording of this target:

- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- An increase in the extent of the EVC is not necessarily desirable if it comes at the expense of other vegetation types.
- Measuring an increase in extent involves measuring areas where the vegetation is not currently present.
- The meaning of 'abundance' is not clear, but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be 2015.
- The target does not specify when the thresholds must be achieved, but it is expected to be 2025.

An alternative target wording is proposed based on the vegetation condition monitoring developed in VEFMAP and WetMAP:

> *The condition of River Red Gum EVCs in the asset is better at the end than at the start of a 10 year monitoring period as measured by the following sub-targets:*
>
> - health of adult River Red Gum trees
> - recruitment and survival of juvenile trees
> - recruitment of understorey vegetation
> - native species cover/abundance
> - native species richness.

Vegetation Target 4B

No amendments were proposed to this target.

Vegetation Target 5

The Vegetation 5 target addresses the LTWP objective to "improve the condition of black box dominated EVCs" in the Victorian Murray WRPA. The target is:

> *Increase distribution, [species] richness and abundance of riparian vegetation in black box dominated EVCs.*

There are difficulties with the wording of this target:

- Black box EVCs rarely occur in riparian areas and this reference should be removed from the target.
- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- Due to the long response times involved, changes in the extent of black box EVCs are not realistic within the time frame of the LTWP.
- The meaning of 'abundance' is not clear, but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be from 2015 to 2025.

An alternative target wording is proposed based on WetMAP:

> *The condition of black box dominated EVCs in the asset is better at the end than at the start of a ten year monitoring period as measured by the following sub-targets:*
>
> - health of adult black box trees
> - recruitment and survival of juvenile trees
> - recruitment of understorey vegetation
> - native species cover/abundance
> - native species richness.

Vegetation Target 6

Vegetation Target 6 addresses the LTWP objective to "Improve the condition of shrub and lignum dominated EVCs". The target is:

> *Increase distribution, [species] richness and abundance of riparian vegetation in shrub and lignum dominated EVCs.*

There are some problems with the wording of this target:

- Shrub and lignum EVCs rarely occur in riparian areas and this condition should be removed from the target.
- To make the target relate more specifically to wetland shrubland species, it would be helpful to specify "Canegrass or Lignum dominated EVCs".
- The meaning of 'distribution' is not clear, but is expected to mean 'extent'.
- An increase in the extent of the EVC is not necessarily desirable if it comes at the expense of other vegetation types.
- Measuring an increase in extent involves measuring areas where the vegetation is not currently present.
- The meaning of 'abundance' is not clear, but is expected to mean 'vegetation cover/abundance'.
- The target does not specify a baseline against which the increase will be measured, but it is expected to be from 2015 to 2025.

An alternative wording is proposed based on WetMAP and VEFMAP:

The condition of Canegrass or Lignum dominated EVCs is better at the end than at the start of a ten year monitoring program as measured by the following sub-targets:

- condition of Lignum
- cover of canegrass (there is no recognised condition assessment method for canegrass)
- native species cover/abundance
- native species richness.

Other Target 1

Other Target 1 addresses the LTWP objective to "maintain adequate surface water salinity to enable growth and reproduction of aquatic vegetation " in the Wimmera Mallee WRPA. The target is:

Salinity targets for the Wimmera River at Horsham Weir (end of valley target) met 100% of the time.

The Murray-Darling Basin Salinity Management Strategy sets end-of-valley salinity targets for major anabranches. The salinity targets are presented in Schedule B of BSMS2030 (Murray-Darling Basin Ministerial Council, 2015). The salinity target for the Wimmera River is:

- Median 1,380 EC.
- Peak (eightieth percentile) 1,720 EC.
- The AWRC Site Number is 415200.

End of valley salinity targets are assessed over a benchmark period. The valley report cards calculate compliance over a financial year.

There are difficulties with the wording of this target:

- The target does not specify a compliance period over which the median and eightieth percentile will be calculated. Because the end of valley targets are based on percentiles, salinity values can temporarily exceed the EC threshold as long as the median or eightieth percentile is lower over the compliance period.

It is recommended that this target is clarified to read:

End-of-valley salinity targets for the Wimmera River at Horsham Weir of median 1,380 EC and eightieth percentile 1,720 EC are met in every year in the ten years to 2025.

Other Targets 2, 3

Other Targets 2 and 3 addresses the LTWP objective to "maintain species richness of frog communities" in the Northern Victorian WRPA and Victorian Murray LTWP, respectively. Both targets are:

Maintain the number of native frog species recorded in 80% of years to 2025.

There are difficulties with the wording of this target.

- The target does not specify how the baseline frog diversity is defined. This could be the number of species observed in 2015 using a specified method. A difficulty here is that 2015 may not be a representative year to observe frogs. Alternatively the baseline could be the number of species observed over several years preceding 2015 from a range of sources. A difficulty with this approach is it could include more frog species than a single standardised method can detect.
- It would be less ambiguous to say that the number of species must not be less than the threshold in eight of the ten years to 2025.

The number of observed species can increase with survey effort. It is important that a consistent method is used. An alternative wording is proposed:

The number of frog species observed in eight in a ten years period must be more than 75% of the highest diversity recorded in any one year

Appendix E Priority environmental asset goals and objectives

The table below lists management goals and objectives for each priority environmental asset in the Northern Victoria water resource plan area. Goals and objectives are taken from the relevant EWMPS.

The information in Table 29 presents some of the key planning information collated from the EWMPs for the relevant priority environmental assets in the Northern Victoria water resource plan area. Note that this information is only intended to provide an indication of the level of planning undertaken by catchment management authorities for these sites. Please refer to the individual EWMP for full information on the relevant site. All Victorian Basin Plan EWMPs are available at https://www.water.vic.gov.au/waterways-and-catchments/rivers-estuaries-and-waterways/environmental-water/environmental-water-management-plans .

Table 29: Management goals and objectives for each priority environmental asset in the Northern Victoria water resource plan area

Asset Name	Management Goal	Objective	Basin Plan Theme
Birch's (Bullarook Creek)	• To establish resilient breeding populations of Platypus and small to medium bodied native fish including River Blackfish and provide opportunities for these animals to disperse to Creswick and Tullaroop Creeks. • To maintain and increase a diverse mosaic of in-stream, fringing and riparian native vegetation.		
		Primary 1: Increase abundance and diversity of native fish such as river blackfish, mountain galaxias, flatheaded gudgeon and Australian smelt.	Fish
		P2: Provide conditions that consistently support widespread successful breeding by Platypus to increase population resilience to future drought and floods and to provide surplus juveniles that can disperse to Creswick Creek and Tullaroop Creek.	Other Fauna
		Secondary 1: Maintain and increase overall abundance, diversity and productivity of macroinvertebrates and macroinvertebrate functional feeding groups to drive productive and dynamic food webs.	Invertebrates
		S2: Provide habitat and flow conditions that will allow river blackfish to re-establish in Reaches 1 & 2.	Fish
		S3: Maintain water quality that is able to support aquatic biota and ecological processes. Specifically: • Limit nutrient concentrations to prevent excessive algal growth and blooms. • Maintain dissolved oxygen levels above 2 mg/L in dry periods. • Prevent water temperature declining below 160C during late Spring/Early Summer.	Water Quality
		S4: Maintain (Reach 3) and improve (Reaches 1 & 2) diversity and abundance of instream aquatics such as *Triglochin procerum, Myriophyllum verrucosum, Potamogeton crispus, P. ochreatus* and *Vallisneria americana*.	Vegetation
		S5: Reduce dominance of exotic instream aquatics such as Elodea (especially in Reaches 1 and 2).	

		S6: Maintain and improve abundance and diversity of emergent fringing vegetation such as *Bolboschoenus medianus spp.*, *Phragmites australis* and *Typha domingensis* on benches and edges of channel, but limit their encroachment into the middle of the channel.	
		S7: Maintain (Reach 3) and restore (Reaches 1 & 2) adult riparian woody vegetation (e.g. swamp gum, manna gum, river red gum) and facilitate recruitment.	
Broken River	• Maintenance of the frequency or magnitude of flows required to maintain or improve in-channel geomorphic and habitat diversity; • The maintenance of baseflow to provide habitat for instream aquatic and emergent vegetation, which in turn provides habitat for invertebrates and fish; • Maintenance of the frequency, depth and duration of events required to inundate floodplain and wetland areas and associated threatened EVC or plant species; • Maintenance of riffle, run and pool habitat, surface water area and refugia for macroinvertebrates and native fish during extended periods of low flow; • Maintenance of the frequency and duration of floodplain/wetland inundation events to provide organic matter (to drive productivity) and habitat for invertebrates; • Provision of flow cues to stimulate the movement of native fish; • Provision of sufficient depth to allow the movement of fish along their natural range		
		G1: Provide baseflow adequate to allow the persistence of aquatic macrophytes at the bank toe.	Geomorphology
		G2: Provide baseflow to prevent terrestrial vegetation colonizing the stream bed, while also preventing bank slumping.	
		G3: Maintain the rates of bed material movement to maintain bed diversity (sand and gravel bed).	
		G4: Flows to turn over bed sediments in runs and scour around large wood.	
		G5: Provide bench inundation to maintain bench form (and wet vegetation and promote the deposition/retention of organic matter).	
		G6: Maintain connectivity between the channel, anabranches and wetlands.	
		R1: Improve the longitudinal and lateral extent and condition of remnant native vegetation at the top of the bank and on the floodplain, with a focus on EVC 56: Floodplain Riparian Woodland.	Vegetation
		W1: Maintain a mosaic of wetlands features, including maintenance of individual wetland/vegetation components within Floodplain Wetland Aggregate EVC.	
		W2: Maintain lateral linkages (hydrological and biological) between floodplain wetlands and main-stream channel of river.	
		IC1: Maintain the ruderal–temporary character of cobble and gravel riffles.	
		IC2: Minimise the opportunities for woody species to establish and persist on in-channel cobble and gravel bars.	
		IC3: Minimise the opportunities for woody species to establish and persist on in-channel sand bars.	
		IC4: Slough filamentous algae and refresh biofilms on hard surfaces.	

		IC5: Restore in-channel native submerged and emergent vegetation.	
		IC6: Inundate benches, bars and low levels of the river bank to entrain organic matter and drive ecological processes such as carbon and nutrient cycling	
		MI1: Maintain areas of riffles and runs.	Invertebrates
		MI2: Maintain hydraulic habitat diversity to ensure that there is sufficient water to provide flowing and slackwater habitats within the channel.	
		MI3: Maintain habitat for macrophytes that provide crucial habitat for macroinvertebrates.	
		MI4: Scour fine sediment from the surface of the substrate to promote biofilm productivity.	
		MI5: Provide floodplain connection for exchange of organic matter and fine sediment.	
		MI6: Retain natural seasonality to ensure synchronicity of life cycle stages with appropriate flows.	
		NF1: Provide low flows that maintain adequate habitat for native fish populations, particularly slackwater habitats and deep pools.	Fish
		NF2: Provide flows sufficient to allow fish passage.	
		NF3: Provide to water access to billabongs and flood-runners to provide additional habitat diversity and food sources that contribute to production.	
		NF4: Provide flow cues to stimulate movements.	
Campaspe River	To rehabilitate the Campaspe River's highly valued and ecologically important river red gum communities, native fish populations and facilitate its connection to the River Murray through the provision of an appropriate water regime.		
		Maintain/Increase river red gum: To maintain adult river red gum trees and facilitate successful recruitment.	Vegetation
		Increase native fish: To increase the population size, with an appropriate age structure of small and large bodied native fish known to occur in the Campaspe River (e.g. golden perch, Murray cod and Murray-Darling rainbowfish).	Fish
		2.1 Maintain/increase diversity and productivity of macroinvertebrates and macroinvertebrate functional feeding groups.	Invertebrates
		2.2 Increase extent/maintain emergent littoral macrophytes (e.g. phragmites, rushes, reeds and sedges) on benches and edges of channel, but limit their encroachment into the middle of the channel.	Vegetation
		2.3 Increase extent/maintain instream aquatic plants (e.g. water ribbons, eel grass).	
		2.4 Control salinity and stratification in deep pools.	Water Quality
		Facilitate recolonisation by native fish species that have been presumed lost e.g. trout cod, river blackfish and Macquarie perch.	Fish
		Platypus - Maintain/increase resident breeding population by facilitating successful recruitment at least every second year and promote safe dispersals by juveniles.	Other Fauna

		Maintain/Improve connectivity between the Campaspe River reaches and between the Campaspe River and the River Murray	Connectivity
Coliban River	To rehabilitate resilient breeding populations of platypus and small-bodied native fish in the upper half of the Coliban River through maintaining and increasing the cover and diversity of in-stream, fringing and riparian native vegetation communities, and to provide opportunities for these animals to disperse throughout the lower half of the river and beyond.		
		F1 Increase abundance and diversity of opportunistic small-bodied native fish such as Australian smelt, flatheaded gudgeon and mountain galaxias.	Fish
		F2 Provide habitat and flow conditions that will allow river blackfish to re-establish.	
		P1 Provide conditions that consistently support widespread successful breeding of platypus to increase its resilience to future drought and floods and to provide surplus juveniles that can disperse to and colonise other suitable waterways.	Other Fauna
		V1 Maintain and increase cover and diversity of instream aquatics such as *Triglochin procerum*, *Myriophyllum varrifolium* and *Potamogeton spp*.	Vegetation
		V2 Maintain and increase abundance and diversity of emergent fringing vegetation such as phragmites, juncus and Bolboschoenus on benches and edges of channel, but limit their encroachment into the middle of the channel.	
		V3 Maintain adult riparian woody vegetation (e.g. river red gum, *Callistemon sieberi*, *Leptospermum lanigerum*, and *Acacia provincialis*) and facilitate recruitment.	
		WQ1 Maintain water quality that is able to support aquatic biota and ecological processes. Specifically: • Limit nutrient concentrations to prevent excessive algal growth and blooms. • Maintain dissolved oxygen levels above 2 mg/L in dry periods. • Prevent water temperature rising to dangerous levels and electrical conductivity rising above 3,000 EC.	Water Quality
		M1 Maintain and increase overall abundance, diversity and productivity of macroinvertebrates and macroinvertebrate functional feeding groups to drive productive and dynamic foodwebs.	Invertebrates
		G1 Maintain channel form, replenish benches and scour pools to maintain their depth.	Geomorphology
		G2 Clean substrates including rocks, submerged wood and macrophytes.	
Doctors Swamp	To provide a watering regime that supports Red Gum Swam and Plains Grassy Wetland EVCs and provides breeding opportunities for a diverse range of native wetland biota.		
		Achieve a diversity of native wetland flora species consistent with Red Gum Swamp and Plains Grassy Wetland EVC benchmark.	Vegetation
		Reduce the cover and diversity of exotic flora species.	

		Provide opportunities for waterbird breeding.	Waterbirds
		Provide opportunities for native frog breeding at least one in three years.	Other Fauna
Gaynor Swamp	To provide a more natural hydrological regime that supports Red Gum Swamp and Freshwater Lignum – Cane Grass Swamp EVCs and habitat for significant waterbird and flora species.		
		Reinstate the diversity of native wetland flora species to be consistent with Red Gum Swamp and Freshwater Lignum – Cane Grass Swamp EVC benchmarks.	Vegetation
		Reduce the cover and diversity of exotic and/ or highly invasive native flora species.	
		Reinstate populations of Spiny Lignum and Salt Paperbark.	
		Maintain or increase the diversity and abundance of frog species supported by the wetland during flood events.	Other Fauna
		Provide opportunities for waterbird breeding especially Brolga during flood events.	Waterbirds
Goulburn River	Protect and improve the Goulburn River's important aquatic flora and fauna, instream habitats, connected floodplains and ecological processes.		
		Increase the abundance, spatial distribution and size class diversity of key native fish species.	Fish
		Increase the abundance of richness of aquatic and flood dependent native species.	Vegetation
		Increase macroinvertebrate biomass and diversity.	Invertebrates
		Protect and promote natural channel form and dynamics (e.g. sediment diversity, rate of sediment transport and bank erosion rates).	Geomorphology
		Increase instream physical habitat diversity (e.g. shallow and deep water habitats).	
		Provide sufficient rates of in-stream primary production and respiration to support native fish and macroinvertebrate communities.	Processes
Lake Boort	To provide a water regime that supports the recruitment and maintenance of river red gum habitats, and ensures opportunities for waterbird foraging, nesting and breeding.		
		Restore the distribution of live river red gums and associated floristic community (EVC 292) across the bed of Lake Boort. The number of live river red gums should be approximately ten per hectare with 10% canopy cover (as per the EVC benchmark) in the areas that are currently dominated by dead trees (~60% of wetland bed).	Vegetation

		Reinstate populations of non-tufted graminoids typical of EVC 292 such as southern cane grass and common spike-sedge.	
		Restore and rehabilitate vegetation species diversity typical of aquatic and semi-aquatic environments when the wetland is inundated.	
		Maintain current extent and restore health of black box vegetation surrounding the high water mark of Lake Boort (EVC 803: Plains woodland). Support the provision of open woodland consisting primarily of black box trees at approximately 15 trees per hectare (as per the EVC benchmark).	
Lake Leaghur	To provide a water regime that supports flora and fauna that are typical of a Deep Fresh Marsh, in particular providing key waterbird habitat (breeding and nesting) within a Red Gum Swamp (EVC 292).		
		Maintain the health and restore the distribution of river red gum vegetation (EVC 292) • Maintain health of existing trees. • Provide opportunities for recruitment across the wetland bed.	Vegetation
		Restore Cane Grass populations.	
		Establish breeding opportunities for waterbirds, frogs: e.g. Little Pied Cormorants, Ducks, Great Egret, Spotted Marsh Frog.	
		Restore diverse aquatic and amphibious plant communities in the wet phase and endemic plant communities associated with exposed lake bed and banks during the dry phase.	
		Ensure adequate biomass of macroinvertebrate functional feeding groups and zooplankton to support ecological processes and wetland foodwebs.	Processes
Lake Yando	To provide a water regime that maintains existing mature river red gums (*eucalyptus camaldulensis*), supports the recruitment of new river red gums and promotes the growth of a diverse range of aquatic and amphibious plant species that offer habitat for waterbirds, reptiles and amphibians.		
		Maintain the health and restore the distribution of river red gum and understorey species (such as tangled lignum) associated with Intermittent swampy woodland EVC.	Vegetation
		Rehabilitate EVCs 107 (Lake bed herbland), 653 (Aquatic herbland) and 949 (Dwarf floating aquatic herbland) to benchmark condition • Provide a water regime that supports these EVCs and allows species to complete their lifecycles (i.e. set seed) • Maintain a viable seed bank for these EVCs.	
		Maintain the health and increase the distribution of vegetation associated with Riverine chenopod woodland (EVC 103) • Maintain health of existing black box trees. • Provide opportunities for recruitment of black box and understorey species.	
		Maintain and where necessary rehabilitate the abundance and diversity of waterbirds using the wetland when it is full and as it draws down.	Waterbirds

		Rehabilitate macroinvertebrate and zooplankton production to levels expected in healthy freshwater swamps.	Processes
Loddon River (Middle and Upper), including Pyramid, Serpentine, Tullaroop and Twelve Mile Creeks	To promote a widespread and diverse aquatic fauna community particularly native fish and Platypus, by providing high quality breeding and feeding habitat and where possible facilitating movement throughout the Mid-Murray Floodplain System. Rehabilitate riparian River Red Gum vegetation communities along the river, and where possible connect floodplain habitats, through the provision of an appropriate flow regime.		
		To increase the population size, with an appropriate age structure, of native fish species in the impounded Loddon River System reaches	Fish
		To increase the population size, with an appropriate age structure, and the diversity of native fish species, in the connected mid and lower Loddon River System	
		Increase size of resident breeding Platypus populations and facilitate dispersal of surplus juveniles that can colonise other reaches of the Loddon River and connected catchments.	Other Fauna
		Maintain adult riparian woody vegetation (e.g. River Red Gum, Black Box, Bottlebrush, Tea Tree, Melaleuca and Tangled Lignum – species composition will vary between reaches) and facilitate recruitment adjacent to the river channel and in low lying floodplain areas that are watered via floodrunners	Vegetation
		Maintain low lying floodplain vegetation communities. These communities are characterised by a River Red Gum overstorey and grassy, sedge or lignum understorey.	
Meran Lakes complex	A hydrologically diverse wetland complex comprising permanent, intermittent and episodic freshwater wetlands that support: healthy Aquatic Herbland, Lake bed Herbland and Intermittent Swampy Woodland vegetation classes; a high diversity and periodically high abundance of wetland birds and regionally significant breeding populations of freshwater turtles (e.g. Murray River Turtle).		
Lake Meran		Maintain refuge for and successful recruitment and survival of freshwater turtles, in particular Murray River Turtles.	Other Fauna
		Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds (e.g. White-bellied Sea-eagles, Cormorants and Australian Darter Black Swans and Grebes).	Waterbirds
		Rehabilitate the diversity and abundance of native frog populations to support at least common species in the region such as Pobblebonks, Marsh Frogs, Perons Tree Frogs.	Other Fauna
		Rehabilitate the abundance of large-bodied fish species known to have historically occurred at the site and small-bodied fish species common to the region.	Fish
		Rehabilitate and increase the extent of Aquatic Herbland EVC 653 vegetation toward benchmark condition (e.g. *Myriophyllum spp.*, *Vallisneria spp.*, *Triglochin spp.*, *Potamogeton spp.*).	Vegetation
		Rehabilitate and increase the extent of Lake Bed Herbland EVC 107 vegetation towards benchmark condition (e.g. FFG listed Hoary Scurf-pea and Downy Swainson-pea) on exposed wetland bed.	
		Maintain the extent of emergent aquatic vegetation associated with Tall Marsh EVC 821 (including Typha spp., Juncus spp. and Eleocharis spp.), in the southern basin and higher levels of the mid basin of Lake Meran.	

		Rehabilitate the condition of Intermittent Swampy Woodland towards EVC benchmark condition by: • maintain the health of adult and recently recruited river red gum and black box trees (within the wetted area) and • increase the extent of river red gum Trees • rehabilitate the associated understorey species such as River Coobah (*Acacia stenophylla*), Tangled Lignum (*Duma florulenta*) and various herbs and graminoids.	
		Rehabilitate macroinvertebrate communities to ensure that all expected functional groups (e.g. grazers, shredders, filter feeders etc.) are present and have sufficient biomass to support ecological processes and food webs.	Processes
Little Lake Meran		Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds of various feeding guilds, (e.g. ducks, fish eating birds, deep water foragers, and migratory wading waterbirds).	Waterbirds
		Rehabilitate Aquatic Herbland EVC 653) vegetation toward benchmark condition (e.g. *Myriophyllum spp*., *Triglochin spp*., *Potamogeton spp*.).	Vegetation
		Rehabilitate the condition of Intermittent Swampy Woodland (EVC 821) towards benchmark condition by: • 5.2.1 maintaining the health of adult and recently recruited river red gum and black box trees • increasing the extent of river red gum • rehabilitating the associated understorey species such as River Coobah (*Acacia stenophylla*), Tangled Lignum (*Duma florulenta*) and various herbs and graminoids.	
		Maintain open water and associated mud-flat habitats for sufficient periods during flooding and drying cycles to drive aquatic food webs and support wetland bird feeding and breeding.	Waterbirds
Moodies Swamp	To provide a watering regime that supports a Cane Grass Wetland EVC and its significant biota that occur there, particularly brolgas and milfoils.		
		Maintain the diversity of native wetland flora species to be consistent with Cane grass Wetland EVC benchmark.	Vegetation
		Reduce the cover and diversity of exotic and/ or highly invasive native flora species.	
		Maintain populations of rigid water-milfoil and slender water-milfoil.	
		Provide opportunities for Brolga breeding.	Waterbirds
Ovens River, Buffalo River and King River	Use the environmental water reserve, and water management of the Ovens River, to build viable populations of iconic native fish and ensure that they are resilient.		
		Maintain condition of more adult fish of target species.	Fish
		Maintain survival rates of juveniles of target fish species.	
		Increase / maintain production of larvae of target fish species.	
Reedy Swamp	To provide a more natural hydrological regime that supports waterbird breeding and improves the conditions of existing mosaic of EVCs as well as providing a designated primary drought refuge during times of regional need.		
		Improve the diversity of native wetland flora species consistent with the mosaic of EVC benchmarks.	Vegetation

		Reduce the cover and diversity of exotic and/or highly invasive native flora species.	
		Maintain habitat for colonial waterbird refuge and breeding including Australian White Ibis, Straw-necked Ibis, Royal Spoonbill (v) and Yellow-billed Spoonbills.	Waterbirds
		Maintain or increase diversity and abundance of frog species supported by the wetland during flood events.	Other Fauna
		Provide feeding habitat for significant waterbird species such as Eastern Great Egret, Intermediate Egret, Glossy Ibis and Latham's snipe during flood events.	Waterbirds
Round Lake	Maintain Round Lake as a permanent, saline lake that provides suitable habitat for the threatened Murray hardyhead and submerged aquatic vegetation, particularly Large-fruit Tassel and Charophytes (macroscopic algae).		
		Maintain and support breeding of Murray hardyhead.	Fish
		Maintain populations of Large-fruit Tassel (*Ruppia megacarpa*) associated with Brackish Herbland (EVC 538).	Vegetation
		Maintain Charophytes (macroscopic algae) persisting in the lake.	

Appendix F Priority environmental asset watering requirements

Information on watering requirements for priority environmental assets is taken from the MDBA Environmental Assets and Functions Database (MDBA, 2021) which contains data from relevant Northern Victorian EWMPs. Only wetlands only are included in the below table, due to complexity and volume of information.

Table 30: Watering requirements for wetland priority environmental assets in the Northern Victoria water resource plan area

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH
Horseshoe Lagoon	V1: Protect diversity, recruitment and regeneration of target EVCs from the 2012 - 2019 benchmark by 2025 - Tall Marsh (821)		Y			Autumn to spring	Frequency (years in 10): Min-6; Opt-8; Max-10	Ponding duration: Min-6; Opt-8; Max-11	Max depth: <0.4m		
Horseshoe Lagoon	V1: Protect diversity, recruitment and regeneration of target EVCs from the 2012 - 2019 benchmark by 2025 - Aquatic Herbland (653)/ Floodway Pond Herbland (810)		Y			Autumn to spring	Frequency (years in 10): Min-6; Opt-8; Max-10	Ponding duration: Min-6; Opt-18; Max-36	Max depth: >2m		
Loch Garry	V1: Protect diversity, recruitment and regeneration of target EVCs from the 2012 - 2019 benchmark by 2025 - Rushy Riverine Swamp (804)		Y			Autumn to spring	Frequency (years in 10): Min-6; Opt-8; Max-10	Ponding duration: Min-1; Opt-8; Max-12	Max depth: <1m		
Loch Garry	V1: Protect diversity, recruitment and regeneration of target EVCs from the 2012 - 2019 benchmark by 2025 - Tall Marsh (821)		Y			Autumn to spring	Frequency (years in 10): Min-6; Opt-8; Max-10	Ponding duration: Min-6; Opt-8; Max-11	Max depth: <0.4m		
Loch Garry	V1: Protect diversity, recruitment and regeneration of target EVCs from the 2012 - 2019 benchmark by 2025 - Riverine Swamp Forest (814)		Y			Autumn to spring	Frequency (years in 10): Min-6; Opt-8; Max-9	Ponding duration: Min-3; Opt-6; Max-12	Max depth: <1m		

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH
Loch Garry	V1: Protect diversity, recruitment and regeneration of target EVCs from the 2012 - 2019 benchmark by 2025 - Sedgy Riverine Forest (816)		Y			Autumn to spring	Frequency (years in 10): Min-4; Opt-6; Max-7	Ponding duration: Min-1; Opt-2; Max-3	Max depth: <0.5m		
Loch Garry	V1: Protect diversity, recruitment and regeneration of target EVCs from the 2012 - 2019 benchmark by 2025 - Floodway Pond Herbland (810)		Y			Autumn to spring	Frequency (years in 10): Min-6; Opt-8; Max-10	Ponding duration: Min-6; Opt-18; Max-36	Max depth: <2m		
Lake Boort	Restore the distribution of live River Red Gums and associated floristic community (EVC 292) across the bed of Lake Boort. The number of live River Red Gums should be approximately ten per hectare with 10% canopy cover (as per the EVC benchmark) in the area		Y			Preferred timing of inflows (based on information provided in Roberts and Marston (2011): Late winter/spring	Recommended frequency of events (number per 10 years): To achieve vigorous growth of RRG, the general recommendation is three events per ten years. Specifically for Lake Boort, a watering frequency of between two and four events per ten year period is pro	Duration of flooding (months): Duration of flooding in the target recruitment area should be between approximately five and seven/ eight months. As juvenile RRG begin encroaching through the wetland bed, flood depth should be modified to ensure inundation	Target supply level: 90.79 mADH (FSL fill, event 1)		
Lake Boort	Restore and rehabilitate vegetation species diversity typical of aquatic and semi-aquatic environments when the wetland is inundated		Y			Preferred timing of inflows (based on information provided in Roberts and Marston (2011): Late winter/spring	Recommended frequency of events (number per 10 years): Between annual inundation and three events per ten years will promote growth	Duration of flooding (months): Between eight and 12 months approximately	Target supply level: between 89.50 and 90.79 mADH		

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH
Lake Boort	Maintain current extent and restore health of Black Box vegetation surrounding the high water mark of Lake Boort (EVC 803: Plains woodland). Support the provision of open woodland consisting primarily of Black Box trees at approximately 15 trees per hectare		Y			Preferred timing of inflows (based on information provided in Roberts and Marston (2011): Late winter/spring	Recommended frequency of events (number per 10 years): To achieve vigorous growth of BB, the general recommendation is between one and three events per ten years. Specifically in Lake Boort, a watering frequency of one event per ten year period is propose	Duration of flooding (months): Between three and six months approximately	Target supply level: 90.79 mADH		
Lake Boort	Restore the distribution of live River Red Gums and associated floristic community (EVC 292) across the bed of Lake Boort. The number of live River Red Gums should be approximately ten per hectare with 10% canopy cover (as per the EVC benchmark) in the ar		Y			Preferred timing of inflows (based on information provided in Roberts and Marston (2011): Late winter/spring	Recommended frequency of events (number per 10 years): To achieve vigorous growth of RRG, the general recommendation is three events per ten years. Specifically for Lake Boort, a watering frequency of between two and four events per ten year period is pro	Duration of flooding (months): Duration of flooding in the target recruitment area should be between approximately five and seven/ eight months. As juvenile RRG begin encroaching through the wetland bed, flood depth should be modified to ensure inundation	Target supply level: between 89.50 and 90.00 mADH (events 2 & 3)		
Lake Leaghur	1.1 Maintain the health and restore the distribution of River Red Gum vegetation (EVC 292): Maintain health of existing trees; Provide opportunities for recruitment across the wetland bed		Y			Preferred timing of inflows: Spring/Summer	Recommended number of events in 10 years: Min-2, Opt-3-6, Max-7	Duration of ponding (months): Min-2, Opt-3-6, Max-18	Depth: Not critical for existing trees, variable to avoid fringe effect and promote germination across different elevations.		
Lake Leaghur	1.2 Restore Cane Grass populations	Y	Y			Preferred timing of inflows: Not critical	Recommended number of events in 10 years: Min-1.4-2, Opt-3-4, Max-5	Duration of ponding (months): Min-1, Opt-1-6, Max-6	Depth: 0.1-0.5 m		

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH
Lake Leaghur	1.3 Establish breeding opportunities for waterbirds, frogs: e.g. Little Pied Cormorants, Ducks, Great Egret (Known to breed in Leaghur State Park), Spotted Marsh Frog.			Y		Preferred timing of inflows: Spring, provide top-ups to extend waterbird breeding season if required	Recommended number of events in 10 years: Variable depending on species	Duration of ponding (months): Min-4, Opt-5-10 (extend as required if waterbird breeding occurs), Max-Until fledged	Depth: Variable, but >0.2 m		
Lake Leaghur	2.1 Restore diverse aquatic and amphibious plant communities in the wet phase and endemic plant communities associated with exposed lake bed and banks during the dry phase.		Y			Preferred timing of inflows: Spring	Recommended number of events in 10 years: Min-2, Opt-3-6, Max-7	Duration of ponding (months): Min-4, Opt-4-9, Max-	Depth: >0.3 m		
Lake Leaghur	3.1 Ensure adequate biomass of macroinvertebrate functional feeding groups and zooplankton to support ecological processes and wetland foodwebs				Y		See note	See note			
Lake Meran complex	1.1 Lake Meran - Maintain refuge for and successful recruitment and survival of freshwater turtles, in particular Murray River Turtles				Y	Preferred timing of inflows: N/A	See note	See note	Depth: >1.5 m		
Lake Meran complex	1.2 Lake Meran - Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds (e.g. White-bellied Sea-eagles, Cormorants and Australian Darter, Black Swans and Grebes)			Y		Preferred timing of inflows: Spring - Autumn	Recommended number of events in 10 years: Min-2, Opt-3,Max-10	Duration of ponding (months): Min-7, Opt-10.	Depth: <3.5 m (depth under colonial nesting waterbird nests)		
Lake Meran complex	2.1a Lake Meran - Rehabilitate and increase the extent of Aquatic Herbland EVC 653 vegetation toward benchmark condition (e.g. Myriophyllum spp., Vallisneria spp. Triglochin spp., Potamogeton spp.)		Y			Preferred timing of inflows: Autumn - Spring	Recommended number of events in 10 years: Min-2, Opt-7, Max-9	Duration of ponding (months): Min-4, Opt-8,Max-11.	Depth: >10cm		

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds BWS_FISH
Lake Meran complex	2.1b Lake Meran - Rehabilitate and increase the extent of Lake Bed Herbland EVC 107 vegetation towards benchmark condition (e.g. FFG listed Hoary Scurf-pea and Downy Swainson-pea) on exposed wetland bed.		Y			Preferred timing of inflows: N/A	Recommended number of events in 10 years: Min-1, Opt-2, Max-3	Duration of ponding (months): These species require the inter drying period	N/A	
Lake Meran complex	2.2 Lake Meran - Maintain the extent of emergent aquatic vegetation associated with Tall Marsh EVC 821 (including Typha spp., Juncus spp. And Eleocharis spp.), in the southern basin and higher levels of the mid basin of Lake Meran		Y			Preferred timing of inflows: Spring - Summer	Recommended number of events in 10 years: Min-2, Opt-8, Max-9	Duration of ponding (months): Min-4, Opt-8, Max-12	Depth: 0.3 – 1.5m	
Lake Meran complex	2.3a(i) Lake Meran - Maintain the health of adult and recently recruited River Red Gum trees in Intermittent Swampy Woodland.		Y			Preferred timing of inflows: Spring - Summer	Recommended number of events in 10 years: Min-1, Opt-2, Max-3	Duration of ponding (months): Min-2, Opt-4, Max-12	Depth: <1.4 m	
Lake Meran complex	2.3a(ii) Lake Meran - Maintain the health of adult Black Box trees in Intermittent Swampy Woodland.		Y			Preferred timing of inflows: as per natural inflows.	Recommended number of events in 10 years: Min-1, Opt-2, Max-2	Duration of ponding (months): Min-0, Opt-3, Max-6;	Depth: not critical	
Lake Meran complex	2.3b Lake Meran - Increase the extent of River Red Gum Trees		Y			preferred timing of inflows: late spring-early summer	Recommended number of events in 10 years: Min-1, Opt-2, Max-3 (number of desired recruitment events, follow up flooding required)	Duration of ponding (months): Min-1, Opt-2, Max-12	Depth: do not overtop seedlings	
Lake Meran complex	2.3c Lake Meran - Rehabilitate the associated understorey species such as River Coobah (*Acacia stenophylla*), Tangled Lignum (*Duma florulenta*) and various herbs and graminoids.		Y			Preferred timing of inflows: See note	See note	See note	See note	
Lake Meran complex	3.1 Lake Meran - Rehabilitate macroinvertebrate communities to ensure that all expected functional groups (e.g. grazers, shredders, filter feeders etc.) are present and have sufficient biomass to support ecological processes and food webs.				Y	Preferred timing of inflows: Autumn - Spring	Recommended number of events in 10 years: Min-2, Opt-7, Max-9	Duration of ponding (months): Min-4, Opt-8, Max-11	N/A	

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds BWS_FISH
Lake Meran complex	4.1 Little Lake Meran- Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds of various feeding guilds, (e.g. ducks, fish eating birds, deep water foragers, and migratory wading waterbirds)			Y		Preferred timing of inflows: Aug-May	See note	See note	See note	
Lake Meran complex	5.1 Little Lake Meran- Rehabilitate Aquatic Herbland EVC 653) vegetation toward benchmark condition (e.g. Myriophyllum spp., Triglochin spp., Potamogeton spp.)		Y			Preferred timing of inflows: Autumn - Spring	Recommended number of events in 10 years: Min-2, Opt-7, Max-9	Duration of ponding (months): Min-4, Opt-8, Max-11	N/A	
Lake Meran complex	5.2a(i) Little Lake Meran- Maintain the health of adult and recently recruited River Red Gum trees in Intermittent Swampy Woodland		Y			Preferred timing of inflows: Spring - Summer	Recommended number of events in 10 years: Min-1, Opt-2, Max-3	Duration of ponding (months): Min-2, Opt-4, Max-12	Depth: <1.4m (depth near trees)	
Lake Meran complex	5.2a (ii) Little Lake Meran- maintain the health of adult and recently recruited Black Box trees in intermittent Swampy Woodland		Y			preferred timing of inflows: As per natural.	Recommended number of events in 10 years: Min-1, Opt-2, Max-2	Duration of ponding (months): Min-0, Opt-3, Max-6	Depth: not critical	
Lake Meran complex	5.2b Little Lake Meran- Increase the extent of River Red Gum in Intermittent Swampy Woodland		Y			Preferred timing of inflows: Late Spring – Early Summer.	Recommended number of events in 10 years: Min-1, Opt-2, Max-3	Duration of ponding (months): Min-1, Opt-2, Max-12	Depth: Do not overtop seedlings.	
Lake Meran complex	5.2c Little Lake Meran- Rehabilitate the associated understorey of Intermittent Swampy Woodland species such as River Coobah (*Acacia stenophylla*), Tangled Lignum (*Duma florulenta*) and various herbs and graminoids.		Y			Preferred timing of inflows: As per overstory species	See note	See note	See note	
Lake Meran complex	6.1 Little Lake Meran- Maintain open water and associated mud-flat habitats for sufficient periods during flooding and drying cycles to drive aquatic food webs and support wetland bird feeding and breeding.				Y	See note	See note	See note	See note	

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH
Lake Yando	Maintain the health and restore the distribution of river red gum and understorey species (such as tangled lignum) associated with Intermittent swampy woodland EVC		Y			Preferred timing of inflows: Not critical, but more growth and regeneration achieved if flooded during spring-Summer	Recommended number of events in 10 years: Min-1, Opt-2, Max-3	Duration of ponding (months): Min-1-3, Opt-3-6, Max-6	Depth: Not critical for mature trees, but juveniles not to be fully inundated		
Lake Yando	Maintain and Rehabilitate EVCs 107 (Lake bed herbland), 653 (Aquatic herbland) and 949 (Dwarf floating aquatic herbland) to benchmark condition Provide a water regime that supports these EVCs and allows species to complete their lifecycles (i.e. set seed)		Y			Preferred timing of inflows: Late winter/Spring	Recommended number of events in 10 years: Min-2, Opt-3, Max-5	Duration of ponding (months): Min-1, Opt-6, Max-12	Depth: 0.4-1 m.		
Lake Yando	Maintain the health and increase the distribution of vegetation associated with Riverine chenopod woodland (EVC 103): Maintain health of existing black box trees; Provide opportunities for recruitment of black box and understorey species.		Y			Preferred timing of inflows: Spring	Recommended number of events in 10 years: Min-1, Opt-2, Max-3	Duration of ponding (months): Min-2, Opt-3-7, Max-12			
Lake Yando	Maintain and where necessary rehabilitate the abundance and diversity of waterbirds using the wetland when it is full and as it draws down.			Y		Preferred timing of inflows: Winter/Summer	Recommended number of events in 10 years: Min-3, Opt-5-10, Max-10	Duration of ponding (months): Min-4, Opt-6, Max-12	Depth: variable.		
Reedy Swamp	Improve the diversity of native wetland flora species consistent with the mosaic of EVC benchmarks		Y			Preferred timing of inflows: Autumn – Early Spring	Recommended number of events in 10 years: Min-4, Opt-6, Max-10	Duration of ponding (months): Min-6, Opt-6-10, Max-12-18	Depth: variable to 1m		

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH
Reedy Swamp	Maintain habitat for colonial waterbird refuge and breeding including Australian White Ibis, Straw-necked Ibis, Royal Spoonbills (v) and Yellow-billed Spoonbills.			Y		Preferred timing of inflows: Spring (Filling wetland from dry based on calculations of environmental water delivery to Reedy Swamp (Committee, 2011)).	Recommended number of events in 10 years: Min-4, Opt-6, Max-10	Duration of ponding (months): Min-6, Opt-6-9, Max-N/A	Depth: Variable to 1m ((ARC, 2010), Appendix 9).		
Reedy Swamp	Maintain or increase diversity and abundance of frog species supported by the wetland during flood events				Y	Preferred timing of inflows: Spring-Summer.	N/A	Duration of ponding (months): Min-2, Opt-2-6, Max-N/A	Depth: Variable to 1m ((ARC, 2010), Appendix 9).		
Doctors Swamp	Achieve a diversity of native wetland flora species consistent with Red Gum Swamp and Plains Grassy Wetland EVC benchmark		Y			Preferred timing of inflows: Late Autumn – Spring	Mean frequency of events (in 10 years): Min-2, Opt-5-7, Max-10	Median duration of ponding (months): Min-3, Opt-5-9, Max-18* (*Red Gums have been used as the main indicator plants for this watering regime. They should not be wet for more than two consecutive summers (Barlow, 2011). 18 months is the suggested maximum p	Depth: Variable to 600mm.		
Doctors Swamp	Reduce the cover and diversity of exotic flora species		Y			Preferred timing of inflows: Late Autumn – Spring	Mean frequency of events (in 10 years): Min-3, Opt-5-7, Max-10	Median duration of ponding (months): Min-3, Opt-6, Max-9	Depth: Variable to 600mm.		

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH
Doctors Swamp	Provide opportunities for waterbird breeding			Y		Preferred timing of inflows: Spring	Mean frequency of events (in 10 years): Min-3, Opt-10, Max-10	Median duration of ponding (months): Min-6, Opt-8, Max-N/A	Depth: Variable to 600mm (Water depth should be kept fairly consistent if waterbirds are nesting/ breeding to avoid nests being abandoned (Young, 2003)).		
Doctors Swamp	Provide opportunities for native frog breeding at least one in three years.				Y	Preferred timing of inflows: Late Autumn – Spring (ARC, 2010, Appendix 10).	N/A	Median duration of ponding (months): Min-2, Opt-2-6, Max-N/A	Depth: Variable to 600mm.		
Moodies Swamp	Maintain native wetland flora species to be consistent with Cane grass Wetland EVC		Y		Y	Preferred timing of inflows: Autumn – Spring	Recommended number of events in 10 years: Min- 3; Opt-5; Max-10	Duration of ponding (months): Min-3; Opt-6 (six months for deepest area of swamp); Max- 9	Depth: Variable to 500mm.		
Moodies Swamp	Maintain populations of rigid water-milfoil and slender water-milfoil.		Y			Preferred timing of inflows: Late Autumn	N/A	N/A	Depth: Variable to 500mm.		
Moodies Swamp	Provide opportunities for Brolga breeding.			Y		Preferred timing of inflows: Autumn – Spring	Recommended number of events in 10 years: Min- 3; Opt-5; Max-10	Duration of ponding (months): Min-6; Opt-9 ; Max- 12	Depth: Variable to 500mm (Water depth should be kept fairly constant if waterbirds are nesting/ breeding to avoid nests being abandoned (Young 2003).		

Asset Name	Rationale/Objectives	FISH	VEG	WBIRD	OTHER	Watering Period	Watering Frequency	Watering Duration	Watering Depth	BWS WBirds	BWS_FISH
Gaynor Swamp	Improve the diversity of native wetland Flora species to be consistent with Red Gum Swamp EVC benchmarks #.		Y			Preferred timing of inflows: Late Autumn - Spring or spring summer for more growth (More growth achieved for Red Gums if flooded during spring-summer)	Recommended number of events in 10 years: Min-2; Opt-5-7, Max-10	Duration of ponding (months) : Min-2, Opt-6, Max-18 (Red Gums have been used as the main indicator plant for this watering regime. Red Gums should not be wet for more than two consecutive summer)	Depth: variable to 950 mm.		
Gaynor Swamp	Improve the diversity of native wetland flora species to be consistent with Freshwater Lignum-Cane Grass EVC benchmarks.		Y			Preferred timing of inflows: Late Autumn - Spring	Recommended number of events in 10 years: Min-1-3; Opt-3-5, Max-10	Duration of ponding (months) : Min-2-3, Opt-6-8, Max-8-9	Depth: variable to 950 mm.		
Gaynor Swamp	Provide opportunities for waterbird breeding.			Y		Preferred timing of inflows: Spring	Recommended number of events in 10 years: Min-5; Opt-5, Max-10	Duration of ponding (months) : Min-2, Opt-6, Max-N/A	Depth: Maximum of 950 mm		
Gaynor Swamp	Maintain or increase the diversity and abundance of frog species.				Y	Preferred timing of inflows: Spring-Summer	N/A	Duration of ponding (months) : Min-2, Opt-2-6, Max-N/A	Depth: variable to 950 mm.		
Kanyapella Basin Bushland reserve	Improve the diversity of native wetland flora species to be consistent with EVCs #.		Y			Preferred timing of inflows: Winter - Spring	Recommended number of events in 10 years: Min-7, Opt-10, Max-10	Duration of ponding (months): Min-1, Opt-4, Max-6	Depth: variable to 300mm		
Kanyapella Basin Bushland reserve	Provide opportunities for waterbird breeding especially Royal Spoonbills and Ibis during flood events.			Y		Preferred timing of inflows: Spring - Filling wetland based on monitoring of past environmental water deliveries to Kanyapella Basin.	Recommended number of events in 10 years: Min-3, Opt-10, Max-10	Duration of ponding (months): Min-6, Opt-8, Max-N/A	Depth: variable to 300mm (This is estimation only as research on frog survival in dry wetlands for extended periods is limited)		

Appendix G Roles and responsibilities

Table 31 outlines the range of agencies and authorities that are involved in managing and delivering environmental flows.

Table 31: Responsible minister and agencies

Minister / Agency	Responsibilities
Minister for Water	Oversee Victoria's environmental water management policy framework Oversee the VEWH, including appointment and removal of commissioners and creation of rules ensuring VEWH manages the water holdings in line with environmental water management policy. Administer the broader water allocation and entitlements framework and the *Water Act 1989* (Vic)
Department of Environment, Land, Water and Planning (DELWP)	Manage the water allocation and entitlements framework Develop state policy on water resource management and waterway management approved by the Minister for Water Develop state policy for the management of environmental water in regulated and unregulated systems Act on behalf of the Minister for Water to maintain oversight of the VEWH and waterway managers (in their role as environmental water managers)
Victorian Environmental Water Holder (VEWH)	Make decisions about the most effective use of the water holdings, including use, trade and carryover Authorise waterway managers to implement watering decisions Liaise with other water holders to ensure co-ordinated use of all sources of environmental water Publicly communicate environmental watering decisions and outcomes Commission targeted projects to demonstrate ecological outcomes of environmental watering at key sites Report on management of the water holdings
Catchment management authorities (North East, Goulburn Broken, North Central, and Mallee CMAs for this water resource plan area)	Waterway management authorities under Part 10 of the *Water Act 1989* (Vic). Identify regional priorities for environmental waterway management in regional waterway strategies, in consultation with the community Assess water regime requirements of priority rivers, estuaries and wetlands to identify environmental watering needs to meet agreed objectives Identify opportunities for, and implement, environmental works to use environmental water more efficiently Propose annual environmental watering actions to the VEWH and implement the VEWH environmental watering decisions Provide critical input to management of other types of environmental water (passing flows management, above cap water) Report on environmental water management activities undertaken
Commonwealth Environmental Water Holder (CEWH)	Make decisions about the use of commonwealth water holdings, including delegating water to the VEWH for use in Victoria Liaise with the VEWH to ensure co-ordinated use of environmental water in Victoria Report on management of commonwealth water holdings

Minister / Agency	Responsibilities
Water corporations (Goulburn-Murray Water for this water resource plan area)	Work with the VEWH and waterway managers in planning for the delivery of environmental water to maximise environmental outcomes Operate water supply infrastructure such as dams and irrigation distribution systems to deliver environmental water Ensure the provision of passing flows and compliance with management of diversion limits in unregulated and groundwater systems
Formally recognised Traditional Owner groups in the Northern Victoria water resource plan area (Dja Dja Wurrung Clans Aboriginal Corporation.Taungurung Land and Waters Aboriginal Corporation and Yorta Yorta Nations Aboriginal Corporation)	There are currently three different processes[9] for groups to become formally recognised as Traditional Owners of Country in Victoria. This includes holding Registered Aboriginal Party (RAP) status (under the *Aboriginal Heritage Act 2006*), Native Title Determination (under the Commonwealth *Native Title Act 1993*) and entering into a Recognition and Settlement Agreement (under the Victorian *Traditional Owner Settlement Agreement Act 2010*). Chapter 8 of the Victoria Northern and Murray Water Resource Plan (DELWP, 2020) and Aboriginal Victoria provides further information on formal recognition in Victoria.
Murray and Lower Darling Rivers Indigenous Nations (MLDRIN) Federation of Victorian Traditional Owner Corporations (FVTOC)	MLDRIN has a formal role under Basin Plan to advise on development and accreditation of water resource plans. FVTOC has a formal role in advising the State on diverse matters related to water management. Individual Traditional Owner groups may participate in the state's management of natural resources, in recognition of the special relationship of Aboriginal peoples with their land and waters.
Local Government	Specifically with regard to waterways, local government have the following roles and responsibilities: incorporate waterway and catchment management objectives, priorities and actions into strategic and statutory planning processes; undertake elements of floodplain management in accordance with the renewed Victorian Floodplain Management Strategy; • develop and implement urban stormwater plans; • manage on-site domestic wastewater systems; • manage sections of waterways where formal agreements are in place; and • manage rural drainage and infrastructure (e.g. town weirs) where appropriate.
Parks Victoria	Manages parks and conservation reserves in which many waterways are located, including national, State, wilderness, metropolitan and regional parks, sanctuaries and natural features reserves.

[9] A Recognition and Settlement Agreement is negotiated by Traditional Owners with the Victorian Government. Native title is determined by the Federal Court of Australia or, on appeal by the High Court. Determinations and Agreements may differ for each group.

Appendix H Qualitative risk analysis

This appendix documents a qualitative analysis of long-term risks identified for this LTWP. The analysis includes a review of the process that generates the risk, the implications of that process and the options for management of the risk.

Table 32 relates to risks that result in failure to achieve objectives.

Table 33 relates to risks that arise from the provision of environmental water.

Table 32: Risks that result in failure to achieve objectives

Risk category	Threat	Implication	Themes and related objectives at risk	Management options
Failure to provide recommended watering regime	Operational failure in delivery e.g. Water released from dam at incorrect time	Failure to provide appropriate duration, timing, frequency, depth, extent, and velocity of watering	Has potential to impact on all ecological objectives for the water resource plan area	The identified risks can be addressed through the provision of an appropriate flow regime that addresses the objective The provision of water can be complemented with: • Monitoring watering regime and ecological response • Liaison with water authorities, land holders, other stakeholders and the broader community • Prioritisation of watering requirements (in SWP) • Determine environmental water requirements based on seasonal conditions and within constraints • Develop and implement programs to alleviate physical constraints
	Loss of water during delivery	Failure to provide appropriate duration, timing, frequency, depth, extent, and velocity of watering	Has potential to impact on all ecological objectives for the WRPA	
	Constraints that prevent delivery of water e.g. isolation of wetlands from floodplain or river	Failure to provide appropriate duration, timing, frequency, depth, extent, and velocity of watering Reduced lateral connectivity	Has potential to impact on all ecological objectives for the water resource plan area	
	Inadequate conceptual and detailed modelling of water requirements	Failure to provide appropriate duration, timing, frequency, depth, extent, and velocity of watering	Has potential to impact on all ecological objectives for the water resource plan area	Monitoring watering regime and ecological response Update conceptual model with latest research Undertake research to fill knowledge gaps
Failure to undertake complementary works necessary to achieve objective	Poor quality or lack of in-channel habitat associated with past practice e.g. de-snagging and channel modifications	Limited habitat and refuge for target species	Native fish, macroinvertebrates, platypus	Provision of in-channel habitat through large woody debris installation. Management of accelerated rates of erosion and sedimentation within and in adjoining reaches of waterway
	Presence of fish barriers	Reduced longitudinal connectivity	Native fish, aquatic vegetation, platypus	Provision of fish passage over / around structures and or removal of obsolete structures
	Inadequate riparian habitat (includes grazing pressures)	Prevent and regeneration of establishment of appropriate vegetation	Macroinvertebrates, native fish, aquatic and riparian vegetation	Fencing and stock management
	Introduced species	Limits establishment of native vegetation Predation of fauna Competition – reduced habitat and resource availability	Vegetation, platypus, native fish	Monitor introduced species Provide watering regimes that provide competitive advantage for native species Development and implementation of pest management plans Installation of carp screens

Risk category	Threat	Implication	Themes and related objectives at risk	Management options
	Inappropriate fish stocking or excessive recreational fishing	Limits native fish populations through fishing pressure, predation and competition for resources	Native fish	Review fish stocking programs Education programs for recreational fishing
	Poor water quality	Low dissolved oxygen High turbidity High water temperature Increased salinity levels	Fish, Waterbirds, vegetation, amphibians, invertebrates, wetland habitats and types	Monitor groundwater and assets Manage water regime
	Saline groundwater intrusion	Poor vegetation health Limited regeneration and dominance of salt tolerant species Unsuitable habitat for waterbirds and food sources	Vegetation, waterbirds, wetland habitats and types	Monitoring, adaptive management of watering regime Investigate regional groundwater influences
External factors	Climate variability	Extreme low flows	May apply to all objectives	Use seasonally adaptive approach in setting EWRs
	Fire	Altered hydrology, sediment	May apply to all objectives	Monitoring and adaptive management of watering regime
	Land use change	Salinisation, altered hydrology	May apply to all objectives	Monitoring and adaptive management of watering regime
	Climate change	Changes in species composition and hence watering requirements at sites Changes in the variability of flow regimes		Monitoring and adaptive management of watering regime Undertake ongoing research into climate change adaption
Failure to demonstrate achievement of ecological objectives	Delayed ecosystem response	Objective may be achieved, but may not be demonstrated	May apply to all objectives	Monitoring and adaptive management of watering regime Ongoing research into ecosystem response to environmental water
	Monitoring not provided			
	Inadequate research to support conceptual models or monitoring design			

Table 33: Risk that arise from the provision of environmental water

Category	Threat	Implication	Comment and management options
Environmental	Winter high fresh inundate platypus burrows	Limits platypus populations	Deliver winter high fresh in August to trigger female to select or construct nursery burrows at high elevation in the river bank
	Summer fresh mobilises build-up of leaf litter and nutrients	Blackwater event or other water quality issues	Time water events to coincide with cooler water temperatures to reduce microorganism activity Management option is to deliver a summer fresh at the same magnitude as the previous winter low flow therefore the summer fresh will entrain only litter that has built up since the winter low flow was ceased Monitor nutrient and Blue Green Algae levels, and the ecological response of the wetland to flooding
	Other native species (non-target) disadvantaged	Decrease in abundance of non-target species	Identify potential non-target species and monitor the effect of intervention Adapt management intervention to reduce the effects on non-target species
	Watering regime favours non-native species	May competitively inhibit native species	Monitor the abundance of native and invasive aquatic species. Pest management plans and complementary works
	Watering regime initiates erosion	Scour of banks, loss of habitat, sediment mobilisation in large events	Manage rise and fall rates of freshes. Provision of complementary works including revegetation
Social	Inundation of cultural heritage sites	Damage to cultural heritage sites	Monitor condition of sites, communicate with community
	Reduction in recreation opportunity	Use of water for environmental outcome, reduces water available for recreation outcomes	Work closely and engage with local communities Monitor water levels
Economic	Inundation and or erosion of private land and or watering infrastructure (pump equipment)	Community angst and liability	Work closely with land managers, water agencies to provide advanced warning of water delivery Monitor water levels Communicate with landholders and establish watering agreements
	Inundation and or erosion of roads and other transport and communications infrastructure		Work closely with infrastructure managers to provide advanced warning of water delivery Monitor water levels

Appendix I Groundwater

An assessment was made (Groundwater Logic, 2019) of the level of groundwater dependency of priority environmental assets in the Northern Victoria water resource plan area, existing level of management protection for them and hence their level of risk.

Groundwater dependency

The Bureau of Meteorology's Atlas of Groundwater Dependent Ecosystems (GDE Atlas) (Sinclair Knight Merz, 2012) was used to assess groundwater dependence of priority environmental assets in the Northern Victoria water resource plan area. The GDE Atlas includes attributes which indicate the relative potential for groundwater dependence of each feature, based on supporting field and desktop studies (hence being of high potential), and based on remote sensing data analysis, which can range from high to low potential.

For wetland priority environmental asset features the GDA Atlas processing of CDM Smith (2017), who combined two components of the Atlas for assessing the likelihood of wetland features' groundwater dependence:

GDEs reliant on the surface expression of groundwater (i.e. surface GDEs); and

GDEs reliant on the sub surface expression (vegetation) and located in riverine (floodplain or riparian) environments (i.e. subsurface GDEs).

For river priority environmental asset GDEs: only the GDE Atlas' "*GDEs reliant on the surface expression of groundwater*" layer was utilised as input to the GDE confidence level assignments of this study. Only reaches with "desktop study" evidence were classified as "high confidence" for the mapping deliverable of this report (although so too were reaches identified through supplementary desktop studies). Remote sensing-based confidence levels for river reaches were re-classified as follows:

High → moderate; and

Moderate → low.

In this way, river GDEs that have been identified through site-specific desktop studies, which would typically rely on field data analysis (flow and water quality gauging, groundwater potentiometry, tracers, numerical modelling, etc), are classified as being of high confidence in this project's spatial layer deliverable. In contrast, those river GDEs inferred solely through spatially and temporally coarse remote sensing data are classified as being of moderate confidence at best in this project's deliverable.

Management protection

An assessment was then made of the relative level of management protections that are in place for groundwater dependent river priority environmental assets under Victoria's existing water management framework.

Classification of the level of management protection was undertaken as follows:

- High level of management protection:
    - Areas in which specific management triggers are in place to protect GDEs; and/or
    - Areas in which there are existing environmental watering targets specifically aimed at protecting baseflows, as outlined in the LTWPs; and/or
    - Areas in which GDE protections were considered during the licensing process and through sub-catchment specific limits on Permissible Consumptive Volumes, which were derived through assessment of potential pumping impacts (by volume) on stream flows.
- Moderate level of management protection:
    - All other Groundwater Management Units in which there are no specific GDE protections in place, but in which risks to GDEs are identified and assessed for each licence application, in accordance with the relevant policies and Ministerial Guidelines.

Level of Risk

Relative levels of risk posed to each groundwater-dependent priority environmental asset feature were determined as follows:

- Relative Level of Risk = Likelihood x Consequence, where:
    - Likelihood = [1.0 - Level of management protections] x Maximum of ([Scaled shallow groundwater entitlement density] and [Scaled deeper groundwater entitlement density]).
        - The “level of management protections” risk component values were set to: 0.66 (high protection), 0.33 (moderate protection) and 0.0 (low protection).
        - Groundwater use between the shallow and deep aquifers was conservatively treated as being of equal risk – so whichever aquifer class had the greatest groundwater usage density was used in the risk calculation.
    - Consequence = 1.0 for High/Medium/Low confidence GDEs, and 0.0 for non-GDEs (losing reaches). In this case, consequence only considers the sensitivity of a GDE to stressors and does not consider GDE value (all are of equal value in this case). This is considered a conservative approach.
- Risk levels are limited to a maximum of 1.0, and a minimum of 0.0.

Appendix J Waterway types

The table 34 below shows the Australian National Aquatic Ecosystems (ANAE) (Brooks, 2017) waterway type(s) of each priority environmental asset in the Northern Victorian water resource plan area. The full list of ANAE aquatic ecosystem types should be available on Data.gov.au in second half of 2021.

Table 34: Waterway types of priority environmental assets in the Northern Victoria water resource plan area

Asset Name	ANAE Type	Area (ha)
Wetlands and Floodplains		
Lake Boort	Pt1.1.2: Temporary river red gum swamp	404.9
Gaynor Swamp	Pt2.3.2: Freshwater meadow	300.8
Doctors Swamp	Pt2.3.2: Freshwater meadow	224.6
Moodies Swamp	Pt2.3.2: Freshwater meadow	181.4
Meran Lakes Complex	Lp1.1: Permanent lake	174.6
Reedy Swamp	Pt2.2.2: Temporary sedge/grass/forb marsh	130.6
Lake Yando	Pt1.7.2: Temporary lignum swamp	83.0
Lake Leaghur	Lp1.1: Permanent lake	63.4
Round Lake	Psp2.1: Permanent salt marsh	41.7

Appendix K Basin Plan objectives

Table 35. Basin Plan objectives – Chapter 8 environmental watering plan

EWP objective code	EWP objective
Ecosystem type and biodiversity	
8.05,2(a)	An objective is to protect and restore **a subset** of all water-dependent ecosystems of the Murray-Darling Basin, including by ensuring that: declared **Ramsar wetlands** that depend on Basin water resources **maintain their ecological character**; and (Note: see paragraph 21(3)(c) of the Act
8.05,2(b)	An objective is to protect and restore a subset of all water-dependent ecosystems of the Murray-Darling Basin, including by ensuring that: water-dependent ecosystems that depend on Basin water resources and **support the life cycles** of species listed under the **Bonn Convention, CAMBA, JAMBA or ROKAMBA continue to support those species**; and
8.05,2(c)	An objective is to protect and restore a subset of all water-dependent ecosystems of the Murray-Darling Basin, including by ensuring that: water-dependent ecosystems are able to **support episodically high ecological productivity** and its **ecological dispersal**.
8.05,3(a)	An objective is to protect and restore **biodiversity** that is dependent on Basin water resources by ensuring that: water-dependent ecosystems that **support the life cycles** of a **listed threatened species** or **listed threatened ecological community**, or **species treated as threatened or endangered (however described) in State law**, are **protected** and, if necessary, **restored** so that they continue to **support those life cycles**; and
8.05,3(b)	An objective is to protect and restore **biodiversity** that is dependent on Basin water resources by ensuring that: **representative populations** and **communities of native biota** are **protected** and, if necessary, **restored**.
Ecosystem function	
8.06,2	An objective is that the **water quality** of Basin water resources does not **adversely affect** water-dependent ecosystems and is **consistent with the water quality and salinity management plan**
8.06,3(a)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: the **diversity and dynamics** of **geomorphic structures**, **habitats, species and genes** are **protected and restored**; and
8.06,3(b)(i)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: **ecological processes** dependent on **hydrologic connectivity**: (i) **longitudinally along watercourses**;
8.06,3(b)(ii)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: **ecological processes** dependent on **hydrologic connectivity**: (ii) **laterally** between watercourses and their floodplains (and associated wetlands);
8.06,3(b)(iii)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: **ecological processes** dependent on **hydrologic connectivity**: (iii) **vertically between the surface and subsurface**; are protected and restored; and
8.06,3(c)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: the **Murray Mouth remains open** at **frequencies**, for **durations**, and **with passing flows, sufficient** to enable the **conveyance of salt, nutrients and sediment** from the Murray-Darling Basin to the ocean; and
8.06,3(d)	An objective is to protect and restore connectivity within and between water-dependent ecosystems, including by ensuring that: the **Murray Mouth remains open at frequencies, and for durations, sufficient to ensure that the tidal exchanges maintain the Coorong's water quality (in particular salinity levels) within the tolerance of the Coorong ecosystem's resilience**; and Note: This is to ensure that water quality is maintained at a level that does not compromise the ecosystem and that hydrologic connectivity is restored and maintained.

EWP objective code	EWP objective
8.06,3(e)(i)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: the **levels of the Lower Lakes** are managed to ensure **sufficient discharge** to the Coorong and Murray Mouth and help **prevent river bank collapse** and **acidification of wetlands below Lock 1,** and to **avoid acidification** and allow **connection between Lakes** Alexandrina and Albert, by: (i) **maintaining levels above 0.4 metres Australian Height Datum for 95% of the time**, as far as practicable; and
8.06,3(e)(ii)	An objective is to **protect and restore connectivity** within and between water-dependent ecosystems, including by ensuring that: the **levels of the Lower Lakes are managed to ensure sufficient discharge** to the Coorong and Murray Mouth and help **prevent river bank collapse** and acidification of wetlands below Lock 1, and to **avoid acidification** and allow **connection between Lakes** Alexandrina and Albert, by: (ii) **maintaining levels above 0.0 metres Australian Height Datum** all of the time; and
8.06,3(f)	An objective is to protect and restore **connectivity** within and between water-dependent ecosystems, including by ensuring that: **barriers to the passage of biological resources (including biota, carbon and nutrients)** through the Murray-Darling Basin are **overcome** or **mitigated**.
8.06,4	An objective is that **natural in-stream and floodplain processes** that **shape landforms** (for example, the formation and maintenance of soils) are protected and restored.
8.06,5	An objective is to support habitat diversity for biota at a range of scales (including, for example, the Murray-Darling Basin, riverine landscape, river reach and asset class).
8.06,6(a)	An objective is to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations (for example recruitment, regeneration, dispersal, immigration and emigration) including by ensuring that: flow sequences, and inundation and recession events, meet ecological requirements (for example, cues for migration, germination and breeding); and
8.06,6(b)	An objective is to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations (for example recruitment, regeneration, dispersal, immigration and emigration) including by ensuring that: habitat diversity, extent, condition and connectivity that supports the life cycles of biota of water-dependent ecosystems (for example, habitats that protect juveniles from predation) is maintained.
8.06,7	An objective is to protect and restore ecological community structure, species interactions and food webs that sustain water-dependent ecosystems, including by protecting and restoring energy, carbon and nutrient dynamics, primary production and respiration.
Ecosystem resilience	
8.07,2	An objective is that water-dependent ecosystems are resilient to climate change, climate variability and disturbances (for example, drought and fire).
8.07,3	An objective is to protect refugia in order to support the long-term survival and resilience of water-dependent populations of native flora and fauna, including during drought to allow for subsequent re-colonisation beyond the refugia.
8.07,4	An objective is to provide wetting and drying cycles and inundation intervals that do not exceed the tolerance of ecosystem resilience or the threshold of irreversible change.
8.07,5	An objective is to **mitigate human-induced threats** (for example, the impact of alien species, water management activities and degraded water quality).
8.07,6	An objective is to minimise habitat fragmentation.

Note: Coding system is from (Butcher & Fenton, 2020)

Table 36: Basin-wide environmental watering strategy (2019) Expected Environmental Outcomes relevant to Northern Victoria water resource plan area

Theme	Code.	Sub-theme		BWS Expected Environmental Outcome	Relevant to Northern Victoria WRPA	Page of BWS
River flows and connectivity	B1.1	Longitudinal connectivity		To keep base flows at least 60% of the natural level	X	30
	B1.2			A 30% overall increase in flows in the River Murray: from increased tributary contributions from the Murrumbidgee, Goulburn, Campaspe, Loddon and Lower Darling catchments collectively	X	30
	B1.3	Lateral connectivity		A 30 to 60% increase in the frequency of freshes, bank-full and lowland floodplain flows in the Murray, Murrumbidgee, Goulburn–Broken and Condamine–Balonne catchments	X	30
	B1.4			A 10 to 20% increase of freshes and bank-full events in the Campaspe, Loddon and Wimmera catchments	X	30
	B1.5			Current levels of connectivity maintained in the Kiewa, and Ovens catchments	X	
	All river flow and connectivity outcomes are to be achieved by 2024					
Native Vegetation	B2.1	Forests and Woodlands		Maintain current extent of forest and woodland including approximately: 360,000 ha of river red gum 409,000 ha of black box	X	36
	B2.2			No decline in the condition of river red gum and black box across the Basin	X	36
	B2.3		Ovens	Maintain extent and condition** of water-dependent vegetation (10,200ha RRG, <100ha BB) near river channels and on the floodplain	X	108
	B2.4		Goulburn–Broken	Maintain extent of water-dependent vegetation near river channels and on low lying areas of the floodplain. Improve condition of black box and river red gum (19,800ha RRG, 500ha BB)	X	108
	B2.5		Campaspe	Maintain extent and condition** of water-dependent vegetation near river channels (1,900ha RRG, <100ha BB)	X	108
	B2.6		Loddon	Maintain extent and condition** of water- dependent vegetation near river channels (2,200ha RRG, 700ha BB)	X	109

	B2.7		Murray	Maintain extent of water-dependent vegetation near river channels and on low-lying areas of the floodplain. Improve condition of black box and river red gum (90,600ha RRG, 41,700ha BB NSW & Vic).		109
	B2.8			By 2024 improve condition of black box and river red gum	X	36
	B2.9			By 2024 improve recruitment of trees within river red gum and black box communities	X	37
	B2.10	Shrublands		Maintain extent of Lignum along the River Murray from the junction with the Wakool River to downstream of Lock 3, including Chowilla and Hattah Lakes		37
	B2.11	Non-woody vegetation		To maintain the current extent of non-woody vegetation	X	37
	B2.12			By 2024, increased periods of growth for communities that closely fringe or occur within the main river corridors (includes Avoca, Avon, Richardson and Wimmera rivers)	X	37
	B2.13			By 2024, increased periods of growth for communities that form extensive stands within wetlands and low-lying floodplains including Moira grasslands in Barmah–Millewa Forest	X	37
Waterbirds	B3.1			That the number and type of water bird species present in the Basin will not fall below current observations	X	45
	B3.2			A significant improvement in waterbird populations in the order of 20 to 25% over the baseline scenario, with increases in all waterbird functional groups	X	45
	B3.3			Breeding events (the opportunities to breed rather than the magnitude of breeding per se) of colonial nesting waterbirds to increase by up to 50% compared to the baseline scenario	X	45
	B3.4			Breeding abundance (nests and broods) for all of the other functional groups to increase by 30-40% compared to the baseline scenario, especially in locations where the Basin Plan improves over bank flows	X	45
Native Fish	B4.1	Broad outcomes		No loss of native fish spp currently present within the basin	X	49
	B4.2			Improved population structure of key fish species through regular recruitment	X	49
	B4.3			Increased movement of key fish species	X	49
	B4.4			Expanded distribution of key fish species and populations	X	49
	B4.5			Improved community structure of key native fish species	X	49
	B4.6	Short-lived species		Restored distribution and abundance to levels recorded pre-2007	X	49
	B4.7	Moderate to long-		Improved population structure (i.e. a range of size/age classes for all species and stable sex ratios where relevant) in key sites. This will require annual recruitment events in at least eight out of 10 years at 80% of key sites, with at least four of these being 'strong' recruitment events.	X	49
	B4.8			A 10-15% increase of mature fish (of legal take size) for recreational target species (Murray cod and golden perch) in key populations	X	49

	B4.9	lived species		Annual detection of species and life stages representative of the whole fish community through key fish passages; with an increase in passage of Murray cod, trout cod, golden perch, silver perch, Hyrtl's tandan, congolli, short-headed lamprey and pouched lamprey through key fish passages to be detected in 2019–2024; compared to passage rates detected in 2014–2019	X	49
	B4.10			Significant increases in the distributions of key species (see key fish spp table) in the southern Basin.	X	116